RDT&E CENTER MANAGEMENT BRIEFS

VOLUME II

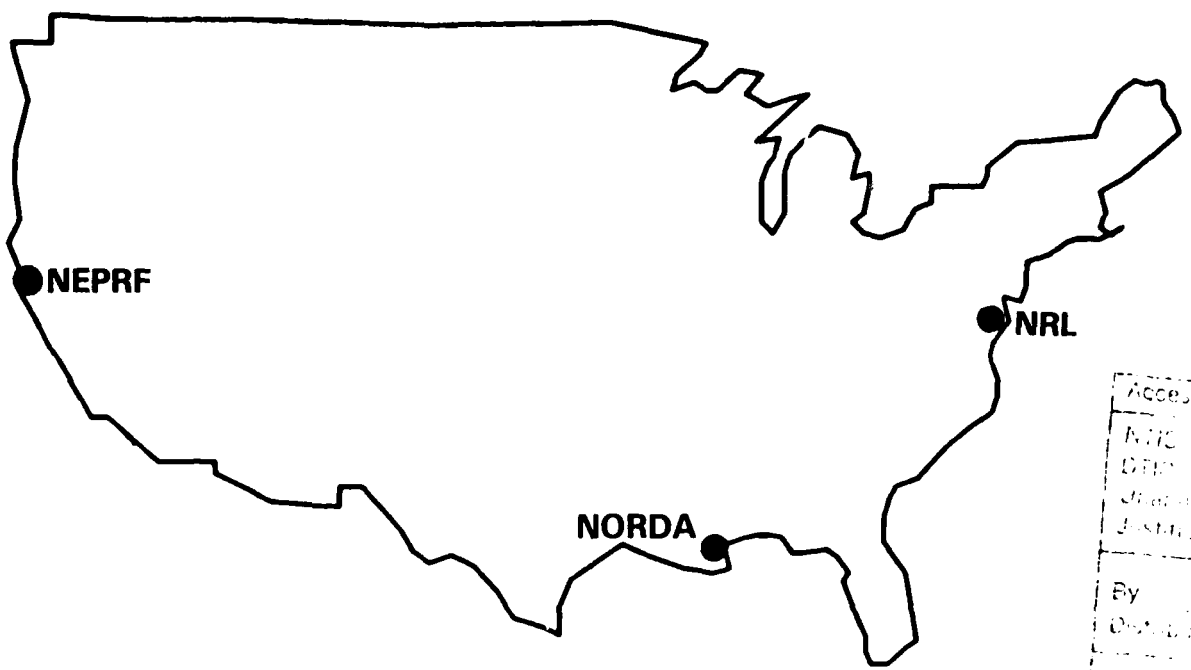
OFFICE OF THE CHIEF OF NAVAL RESEARCH R&D ACTIVITIES

NEPRF NORDA NRL

SPACE AND NAVAL WARFARE SYSTEMS COMMAND
WASHINGTON, DC

30 SEPTEMBER 1987

LOCATION OF CENTERS



NEPRF – NAVAL ENVIRONMENTAL PREDICTION RESEARCH FACILITY
NORDA – NAVAL OCEAN RESEARCH AND DEVELOPMENT ACTIVITY
NRL – NAVAL RESEARCH LABORATORY

FOREWORD

The attached RDT&E center management briefs contain information relative to the missions, facilities, programs, major accomplishments, organization, personnel, funds, and functions/responsibilities of each Office of the Chief of Naval Research R&D Activity. The briefs are intended to provide an accessible source of information pertinent to overall operations of the OCNR R&D Activities. Users are encouraged to provide SPAWAR 005 with any suggestions regarding the briefs (format, content, etc.).

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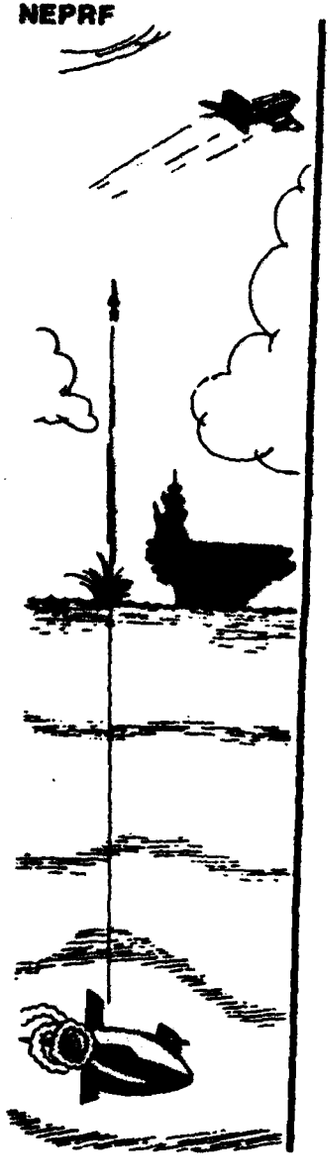

30 SEPTEMBER 1987

NAVAL ENVIRONMENTAL PREDICTION RESEARCH FACILITY BRIEF

NAVAL ENVIRONMENTAL PREDICTION RESEARCH FACILITY

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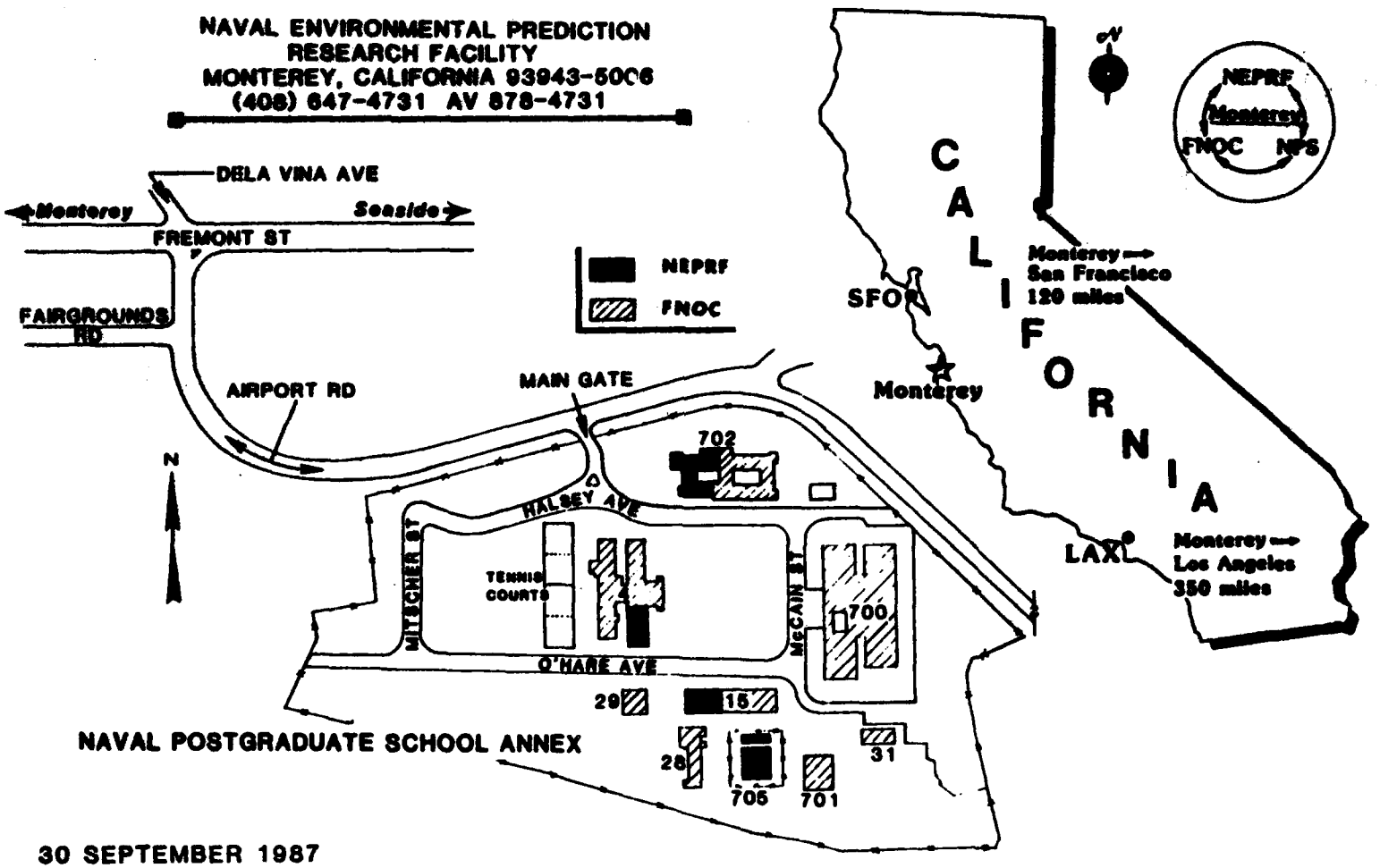

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NEPRF

MISSION

CONDUCT RESEARCH AND DEVELOPMENT DIRECTED TOWARDS PROVIDING OBJECTIVE LOCAL, REGIONAL AND GLOBAL ENVIRONMENTAL ANALYSIS AND PREDICTION TECHNIQUES; AND PROVIDE PLANNING, MODELING AND EVALUATION SERVICES FOR DETERMINING THE EFFECT OF ENVIRONMENTAL ELEMENTS ON NAVAL WEAPON SYSTEMS

30 SEPTEMBER 1987

INTRODUCTION

The Naval Environmental Prediction Research Facility (NEPRF), located in Monterey, California, is a field activity under the Chief of Naval Research in Washington, D.C. NEPRF conducts research in various areas of atmospheric science for the purposes of improving the Navy's local, regional and global weather analysis and prediction capabilities and providing planning, modeling and evaluation services for determining the effect of the atmosphere on Naval weapon systems. NEPRF is the only scientific center in the Navy to be wholly dedicated to atmospheric research.

The goals of the Facility's work are to improve the quality of forecasting techniques and products available to the Fleet ... to increase the Navy's knowledge of the environments in which it operates ... to develop techniques for assessing the effects of atmospheric conditions on ship and air platforms; and on shipboard, airborne and land-based naval communications, sensors and weapon systems ... and to improve techniques for the processing, display and utilization of environmental satellite data in support of fleet operations.

NEPRF has three research departments: Numerical Modeling, Naval Warfare Support, and Weather Analysis and Forecast. Their areas of geophysical research range from the air-sea interface through the earth's atmospheric boundary layer to the lower stratosphere.

FACILITIES

NEPRF is located in Monterey, CA, as a tenant activity of the Naval Postgraduate School (NPS), and is colocated at the NPS Annex with the Fleet Numerical Oceanography Center (FNOC), a major user of NEPRF R&D.

Land Owned/Leased:	0 acres
Buildings:	
RDT&E	22,000 sq ft
Administrative	3,000 sq ft
Other	5,900 sq ft
Acquisition Costs:	
Real Property (Classes I, II)	$0
Equipment (Classes III, IV)	$2,058,360

Among NEPRF's major equipment items are two readout antennas for stretched GOES data, Concurrent Model 3200 computer, MV-4000 and ECLIPSE minicomputers, three HP-9020 and two HP-9845 computers and numerous Zenith 120 and 248 microcomputers. These systems, along with substantial time available on FNOC-owned CDC CYBER 175, 205, 855 and 860 mainframes, are used for the development of faster and more accurate long and short range atmospheric forecasting tools tailored to Navy tactical requirements. NEPRF operates a wide range of other facilities in support of its research mission including a satellite digital data laboratory, meteorological laboratory, electronic maintenance shop, photographic laboratory, and graphics shop, all of which are staffed by highly skilled Navy enlisted personnel. The Facility also maintains a Technical Library which serves the researchers need for environmental literature -- technical reports, reference books, textbooks, programming documents and scientific journals -- in the fields of meteorology, atmospheric physics, air-sea interaction, and other related sciences and technologies.

PROGRAM WORK

NEPRF is a full service Research and Development facility, initiating programs in Exploratory Development (6.2) and seeing them through to Advanced (6.3) and Operational Development (6.6), and finally into operational implementation. The Facility augments the work of its in-house staff with grants and/or contracts to a broad base of universities, private research establishments and other government laboratories.

The Exploratory Development (6.2) component derives most of its tasking from the Atmospheric Support Block (EP2A) which includes Atmospheric Modeling and Atmospheric Remote Sensing.

In addition to conducting local R&D efforts, NEPRF provides technical oversight on efforts of the Naval Research Laboratory (NRL), Naval Postgraduate School (NPS), Naval Air Development Center (NADC) and Pacific Missile Test Center (PMTC) under the overall Program Management of the Chief of Naval Research.

Other Exploratory Development funding comes from the Naval Ocean Systems Center (NOSC) for research on predicting the effects of the atmosphere on electro-optical and electro-magnetic weapons.

The Advanced Development (6.3) component is tasked by NAVSPAWARSYSCOM via the Air-Ocean Prediction and Tactical Environmental Support Systems projects under Program Element 63207N. Additional 6.3 support is received directly via Program Element 63704 to support development of satellite tactical applications.

The Operational Development (6.6) component obtains its tasking from Program Element 35111N, Satellite Data Processing System (SATDAT), from NAVSPAWARSYSCOM. The Commander, Naval Oceanography Command (CNOC) provides the Operations and Maintenance, Navy (O&M,N) funding for operational implementation of various tasks.

The Facility's R&D is performed within its three departments, the technical activities of which are summarized as follows:

1. Numerical Modeling: Develop, test and implement numerical computer models of atmospheric analysis and prediction on scales ranging from marine planetary boundary layer or air/sea interaction phenomena, through regional phenomena (e.g., tropical cyclones, Mediterranean and/or China Sea weather), to global weather, primarily for use on the large main-frame computers at the Fleet Numerical Oceanography Center (FNOC).

2. Naval Warfare Support: Develop, test, and implement numerical synoptic and/or statistical weather forecast techniques, tactical decision aids, and command and control aids for use by Fleet meteorologists, primarily on-site at locations worldwide using directly observed data, satellite information, and/or FNOC computer model forecasts; and to support weapon systems developers to account for environmental effects on systems performance.

3. Weather Analysis and Forecast: Develop, test and implement techniques, forecast aids and applications guides that define the impact of the environment on naval operations and provide environmental information and guidance to tactical planners and commanders by such means as synoptic forecasting guides on a regional scale; statistical techniques for weather analysis/forecasting; and studies of tropical phenomena to support operational forecasting, development of decision aids, and understanding of problems unique to the tropical latitudes. Develop, test and implement techniques for remote field and/or central site processing and display of environmental satellite data.

MAJOR ACCOMPLISHMENTS

Major accomplishments are listed by individual research department.

1. Numerical Modeling (NUMOD)

A new Navy Operational Global Atmospheric Prediction System (NOGAPS 3.0) Operational Check/Operational Test (OPSCHK/OPTEST) began during the summer. The system makes optimum use of both satellite and conventional data and incorporates a sophisticated planetary boundary layer (PBL) that has shown excellent ability to provide detailed surface forecasts of winds and temperatures. NOGAPS 3.0 produces forecasts that are as skillful at five days as the present NOGAPS 2.2 at three days. This improvement will translate into better operational support of all Navy operations that depend on the quality of these forecasts.

The Navy Operational Regional Atmospheric Prediction System (NORAPS) was extensively tested as an Advanced Tropical Cyclone Model (ATCM). ATCM forecasts for all western Pacific typhoons were run in real time during the FY87 season to compare skill with existing forecast aids. The ATCM is better than any other method, but the lack of observational data in the western Pacific continues to be the biggest obstacle to substantial forecast improvements.

Work on NORAPS concentrated on improvements to the objective analysis and PBL. A regional version of the optimum interpolation (OI) analysis used in NOGAPS 3.0 was developed and is being evaluated. A high resolution PBL similar to the NOGAPS 3.0 PBL was also being tested in NORAPS. Both of these efforts will improve NORAPS forecasts either in middle latitude forecast areas or the ATCM area.

A vertically nested higher order closure (HOC) PBL showed considerable promise as a next-generation boundary layer for both NORAPS and NOGAPS descendent models. High resolution

PBL forecasts that directly produce 'sensible' weather information such as cloudiness and refractive structure are possible. Computational costs of the HOC are quite high, so work is concentrated on improving efficiency.

A derivative of the nested HOC PBL work was the development of a trajectory model which uses a HOC model to predict the evolution of an air parcel as it moves through space and time. This allows the combination of NORAPS or NOGAPS forecasts and a HOC PBL forecast to be used to make high resolution point forecasts for modest computational costs. The Tactical Environmental Support system (TESS(3)) is an important potential application for this model.

2. Naval Warfare Support (NWS)

A comparison study of the effects of using climatological data vs. real-time data for predicting laser propagation was performed. Results were documented in a NEPRF technical report. The Naval Postgraduate School was funded to collect shipboard data near San Nicolas Island for future studies of laser propagation in marine environments.

Initial work in support of the High Altitude Long Endurance (HALE) Aircraft commenced with an analysis of climatological winds for Midway Island and Lajes, Azores. This report was used to outline environmental impact on HALE. This work was followed up by a report of environmental support capabilities for HALE, outlining the current support available and possibilities for the future.

An evaluation of current microwave sea clutter models and the possible improvements for these models using better environmental inputs was documented in a preliminary NEPRF technical report. Initial results of the ongoing research, such as integrating a spectral ocean wave model with a simple radar sea clutter model, were also included.

NEPRF

A novel steerable, high resolution acoustic sounder used during the First International Satellite Cloud Climatology Project (ISCCP) Regional Experiment (FIRE) demonstrated the feasibility of obtaining environmental information about the lower marine boundary layer from a research vessel in the open ocean.

A land/sea breeze experiment (LASBEX) was planned and conducted in the Monterey Bay area, based on the availability for a two-week period of the NOAA Wave Propagation Laboratory 10.6 μm Doppler lidar. Unique information on the 3-dimensional velocity field was obtained; the Doppler lidar data were supported by special radiosonde, sodar, and surface weather observations.

A study of meteorological radar and naval usage was completed. The results were reported in a NEPRF technical report. The report summarizes radar meteorology theory, current capabilities, criteria for evaluating radar meteorological applications, current usage in the Navy, and possible future naval applications. A meteorological radar analysis package obtained from the National Severe Storm Laboratory was installed on NEPRF's computer.

Command and Control (C^2) oriented products for the Naval Environmental Display Station (NEDS) continued to gain increasing acceptance by Fleet users. General Acoustic Conditions C^2 graphics were implemented for all ocean basins. This presents, for the first time, real-time data assessment of acoustic conditions over large ocean areas for C^2 decision makers.

The concept to transmit Fleet Numerical Oceanography Center data via AUTODIN to remote terminals for onboard production of C^2 environmental graphics was successfully tested.

A Chemical Warfare Program was developed for the Geophysics Fleet Mission Program Library. The output graphically depicts the dispersal of a chemical agent over the open ocean as well as potential casualty effects.

Work continued in conjunction with the Naval Postgraduate School, on development of an upgraded Forward Looking Infrared (FLIR) performance model. The emphasis this year was on development of a realistic IR ship target and sea surface background model, with at-sea validating data collected in May and November; the results were documented in a Naval Postgraduate School thesis. Utilizing FLIR data collected in May 1986, two other theses documented the accuracy of various FLIR models.

The FLIR model development was enhanced by a cooperative effort between the Navy and the Air Force to test and evaluate the Air Force Strike Warfare Tactical Decision Aids (TDA) for Navy usage. This on-going evaluation is being performed in conjunction with the Naval Oceanography Command and the Naval Strike Warfare Center, Fallon, NV. Adaptation of the TDAs to Navy FLIR systems was initiated to provide high value target capability.

In a cooperative effort with the Naval Postgraduate School, data from several field experiments were analyzed to document the temporal and spatial variability of the refractive structure of the atmosphere. Results were documented in two Naval Postgraduate School theses.

An upgraded ballistic wind and density model was developed and implemented at the Fleet Numerical Oceanography Center. The upgraded model corrected several deficiencies in the old model, and is consistent with the ballistic wind and density model implemented in the Tactical Environmental Support System (TESS).

3. Weather Analysis and Forecast (WAF)

Navy Tactical Applications Guide, Volume 6, part 1, "Tropical Weather Analysis and Forecast Applications" was completed and distributed in March. An initial draft of a "Forecaster's Handbook for Japan and Adjacent Sea Areas" was completed. The final version was to be distributed by the end of the calendar year. Port studies were completed for Gaeta, Catania, Augusta Bay, La Maddalena, Cagliari, and Naples, Italy; Ashdod and Haifa, Israel; Marseille, Toulon, Villefranche, Nice and Cannes, France; Malaga, Spain; and Monaco, with distribution planned on or before December 1987. An update to a Hurricane Havens port study for Norfolk, Virginia was completed and distributed in May.

A 3-D numerical simulation that reproduced the physical mechanisms responsible for a satellite-observed calm zone in the middle of Monterey Bay, California, was completed. Sensitivity testing isolated the conditions conducive to this anomalous effect. A second set of high-resolution 3-D experiments was used to explore cloud-top entrainment instability, the mechanism which is believed to control the breakup of maritime stratus into cumulus. This instability criterion is important because it represents the parameterization which controls subgrid stratus breakup in the Navy's global forecast system (NOGAPS).

The Navy Over-Water Local Atmospheric Prediction System (NOWLAPS), a one-dimensional planetary boundary layer model being designed for TESS(3), was successfully implemented on the HP9845B computer. A manual method for defining the horizontal advection tendency terms onboard ship was designed using a stationary weather station ship as a simulated aircraft carrier; forecasts were made and

compared to analogous forecasts made by the Navy Operational Local Atmospheric Prediction System (NOLAPS), the central-site version of NOWLAPS. In a second battlegroup research effort in support of TESS, the parameterization of overwater diffusion used in the Chemical Weapon Hazard Forecast Program (CHEMFO) was refined to include both relative diffusion and meander.

The Automated Tropical Cyclone Forecasting (ATCF) system currently being developed by NEPRF will allow Joint Typhoon Warning Center (JTWC) forecasters using an IBM PC/AT compatible desktop computer to perform many manual chores including logging, plotting, and error checking of data. The system is also capable of performing some forecast preparation functions such as estimating the storm location, plotting the tracks, computing forecast errors, and preparing messages. One great advantage of using ATCF as the forecasting tool is the standardization of the forecasting procedure. The system can be designed to assist forecasters to follow a predefined Standard Forecasting Procedure which will permit forecasters to consider all available synoptic information. This system can also be used as a training system by adding a Forecasting Decision Aid package that allows forecasters to ask "what if" questions.

A study was carried out to review the performance characteristics of the objective forecast aids currently available at JTWC. For the eight year period of 1978-85, the Half Persistence and Climatology (HPAC) objective aid had the lowest mean 72-hr forecast error. It was not, however, significantly better than the One-Way Interactive Tropical Cyclone Model (OTCM) or the Climatology/Persistence (CLIP) model. The HPAC was excellent in providing

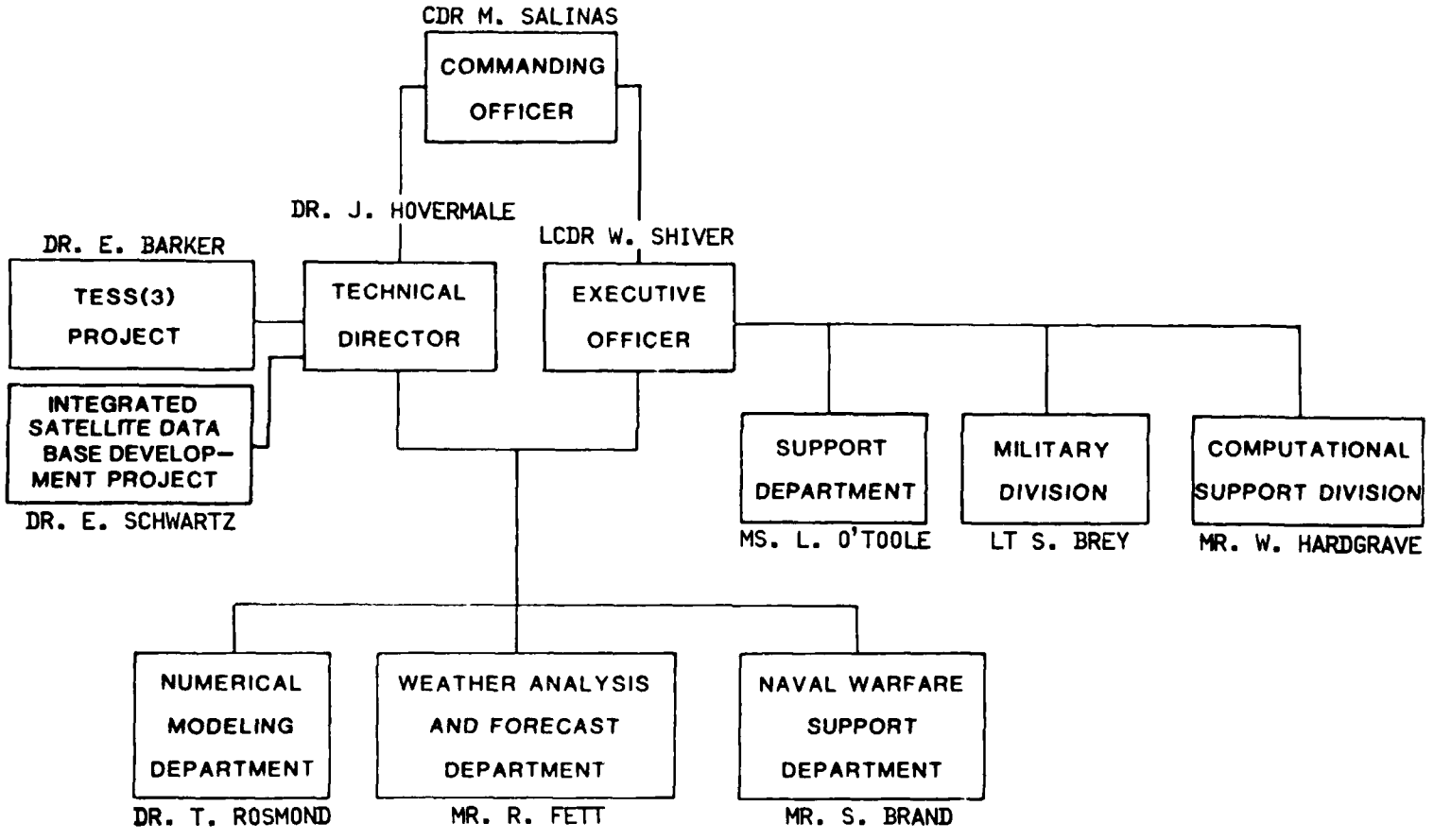
track guidance, while the OTCM gave the best speed forecast. Because of the limited initialization intensities, however, OTCM is less dependable when a tropical cyclone's intensity is less than 63 kt. It was recommended that the large number of objective aids currently available to JTWC be reduced to the few reliable ones.

NASA's fully automated software system for estimating cloud motion vectors (CMV's) from sequences of geostationary satellite images was adapted for use on NEPRF's Satellite Processing Center Upgrade Computer. The system, utilizing multispectral GOES imagery, is a pattern recognition technique known as the Sequential Similarity Detection Algorithm (SSDA). The system requires no manual quality control and produces winds over oceanic regions with random errors comparable in magnitude to existing rawinsonde networks. Experiments were being conducted to determine the most effective way to assimilate the SSDA CMV's into the global and regional multi-variate optimum interpolation schemes.

Numerical model verification was obtained of a boundary layer jet along the marginal ice zone shown to exist when Arctic air flowed parallel to the ice edge. Sensitivity of the jet to changing flow directions was demonstrated.

NEPRF

ORGANIZATION



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NEPRF

PERSONNEL

TOTAL ON BOARD	TOTAL MILITARY	TOTAL CIVILIANS	FTP	TPTI	FTP UNGRADED	FTP GRADED
66	12	54	47	7	0	47

ALLOWANCE

TOTAL CIVILIAN CEILING 56

MILITARY AUTHORIZATION 12
OFFICER 6
ENLISTED 6

ON BOARD

SCIENTISTS AND ENGINEERS 33

ADMINISTRATIVE 11

TECHNICIANS 2

OTHER 1

MILITARY 12
OFFICER 6
ENLISTED 6

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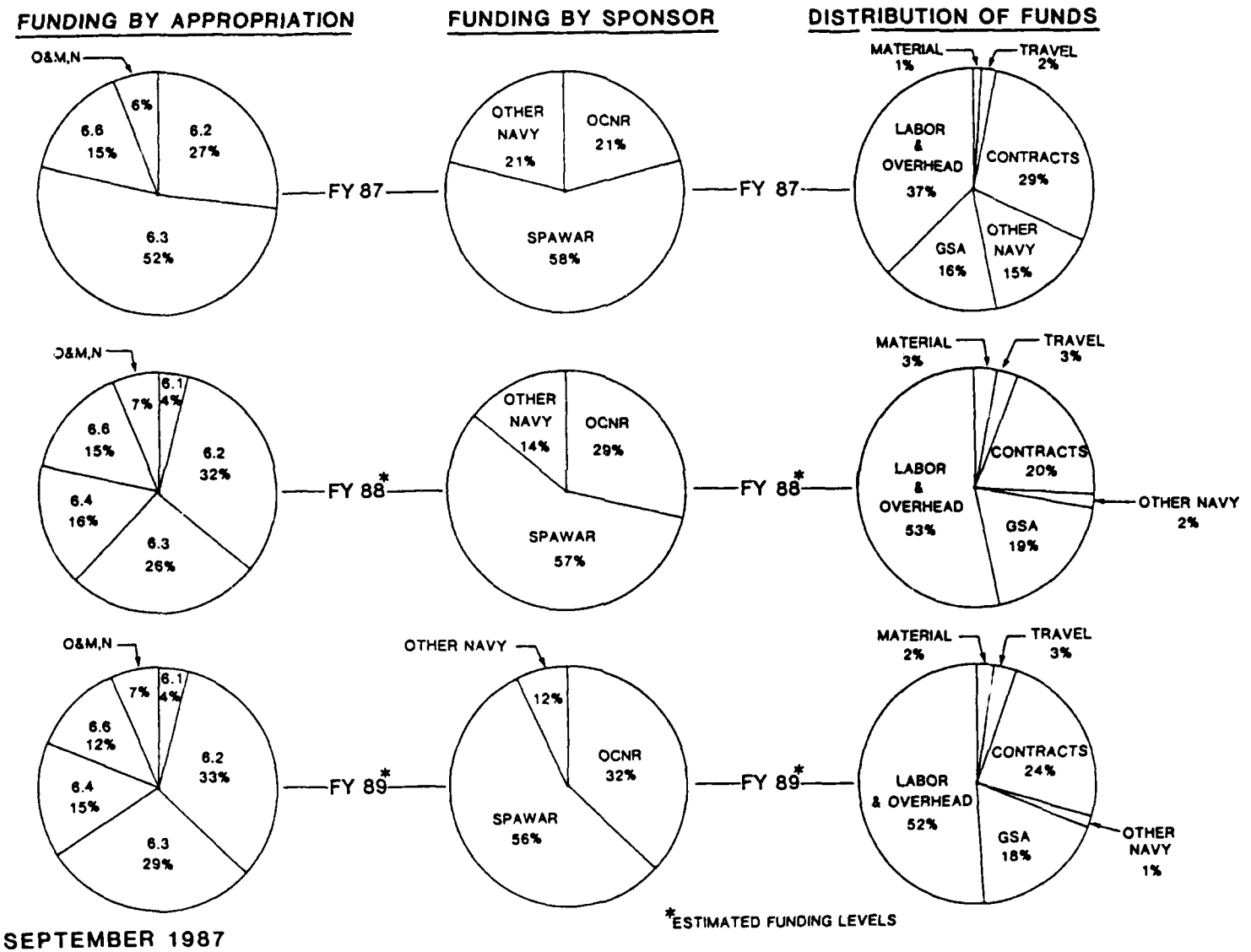
NEPRF



*ESTIMATED FUNDING LEVELS

30 SEPTEMBER 1987

NEPRF

FUNDS BY CATEGORY & TYPE, $K
New Obligational Authority (NOA)

NOA

CATEGORIES & TYPE	FY 1987			FY 1988			FY 1989		
	$K	% OF		$K	% OF		$K	% OF	
	ACT.	RDT&E	TOTAL	EST.	RDT&E	TOTAL	EST.	RDT&E	TOTAL
RDT&E, N (CATEGORY)									
6.1 BASIC RESEARCH	--	--	--	280.0	5.0	4.0	297.9	5.0	4.0
6.2 EXPLORATORY DEVELOPMENT	1912.0	28.0	27.0	2068.7	34.0	32.0	2298.8	35.0	33.0
6.3 ADVANCED TECHNOLOGY DEVELOPMENT	3730.4	56.0	52.0	1677.4	28.0	26.0	2053.7	31.0	29.0
SUBTOTALS	5642.4	84.0	79.0	4026.1	67.0	62.0	4650.4	71.0	66.0
6.4 ENGINEERING DEVELOPMENT	--	--	--	1019.9	17.0	16.0	1023.1	16.0	15.0
6.6 OPERATIONAL DEVELOPMENT	1065.0	16.0	15.0	961.1	16.0	15.0	832.5	13.0	12.0
RDT&E TOTALS	6707.4	100.0	94.0	6007.1	100.0	93.0	6506.0	100.0	93.0
OTHER APPROPRIATION									
(O&M,N) OPERATION & MAINTENANCE, NAVY	397.4		6.0	480.5		7.0	514.3		7.0
GRAND TOTALS	7104.8		100.0	6487.6		100.0	7020.3		100.0

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NEPRF

LEADERSHIP ASSIGNMENTS

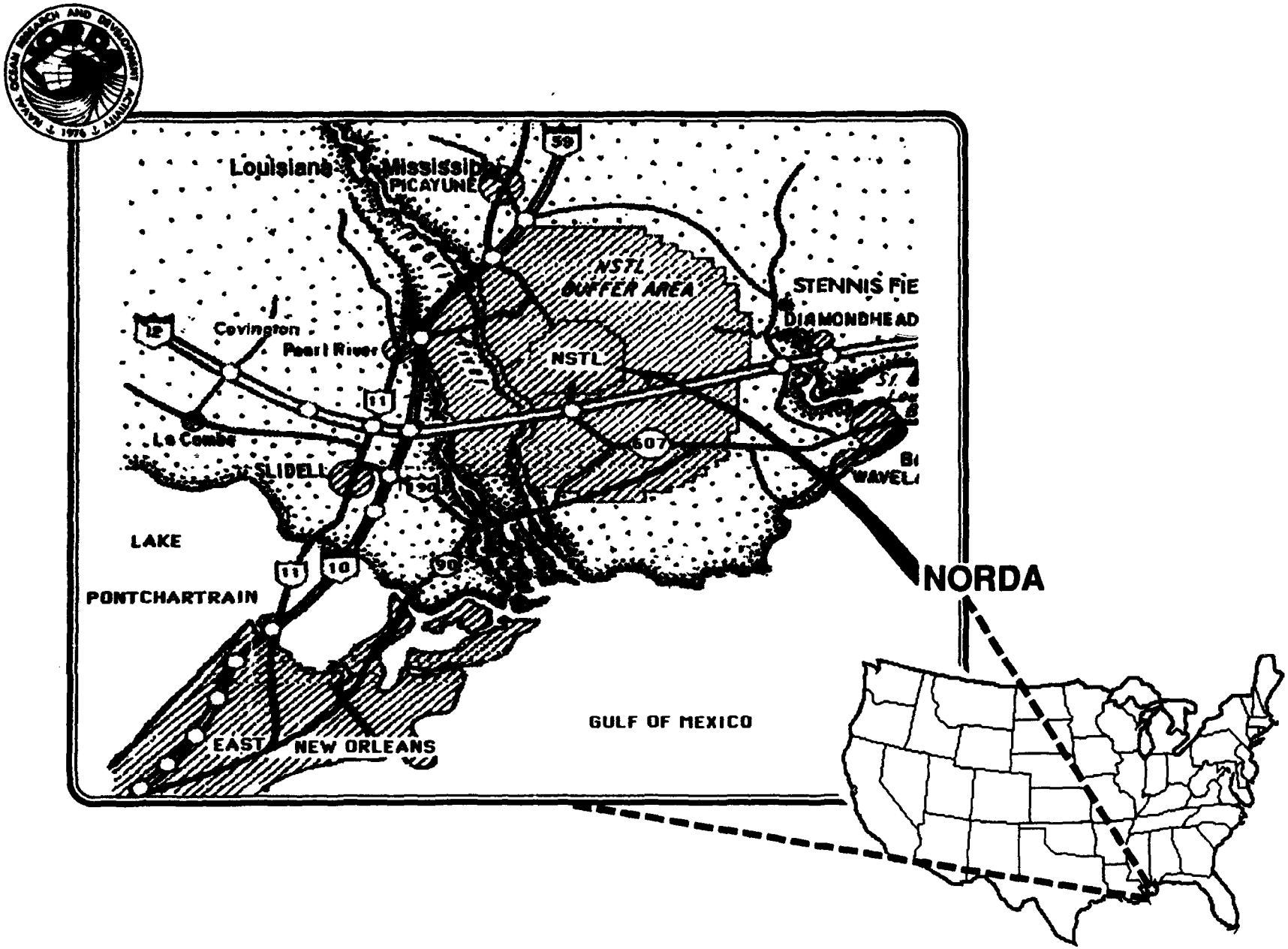
Principal Navy Atmospheric Research & Development Laboratory

- Global Atmospheric Modeling
- Remote Sensing Applications
- Weather Analysis and Forecasting Techniques
- Environmental Command and Control
- Tactical Decision Aids
- Environmental Effects on Weapon Systems
- Technical Direction Agent for Tactical Environmental Support System (TESS 3.0)
- Integrated Satellite Data Base (ISDB) Development

30 SEPTEMBER 1987

NORDA Brief

Approved for public release; distribution unlimited



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MISSION

THE MISSION OF THE NAVAL OCEAN RESEARCH AND DEVELOPMENT ACTIVITY IS TO CARRY OUT A BROADLY BASED RDT&E PROGRAM IN OCEAN SCIENCE AND TECHNOLOGY, WITH EMPHASIS ON UNDERSTANDING OCEAN PROCESSES THROUGH MEASUREMENT AND ANALYSIS AND ON UNDERSTANDING THE EFFECTS OF THE OCEAN ENVIRONMENT ON NAVY SYSTEMS AND OPERATIONS.

30 SEPTEMBER 1987

INTRODUCTION

The Naval Ocean Research and Development Activity (NORDA) was established in 1976 as a field activity of the Chief of Naval Research to become the Navy focal point for ocean environmental research and development.

During its first 11 years, NORDA has evolved into a multidisciplinary, full-spectrum ocean science and engineering research laboratory.

Its research programs have been designed as broad, balanced blends of basic and exploratory ocean research, environmental acoustic research, model development and applications, systems concepts and designs, and advanced engineering developments.

NORDA's corporate goals are the advancement of knowledge of the marine environment and the application and exploitation of this knowledge in support of Navy weapon systems development and the resolution of fleet problems impacted by the ocean environment.

Throughout NORDA's relatively short history, substantial progress can be seen in the continuing growth of a high-quality scientific and support staff and in the state-of-the-art facilities which now support that staff.

NORDA has developed strong programs in oceanography; ocean remote sensing; ocean modeling; ocean acoustics; mapping, charting and geodesy; and geosciences. Innovative measurement systems have been developed by NORDA scientists and engineers to support these programs, many of which are unique in the marine community.

These programs and capabilities are the result of a series of planned investment initiatives, and of the support provided by the Chief of Naval Research to implement these plans.

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FACILITIES

Land Owned/Leased: 0 Acres

Building Space:

RDT&E 103,050 square feet

Administrative	23,230 square feet
Other	84,456 square feet

Administration Costs:

Real Property	17.4 million dollars
Equipment	25.7 million dollars

A decision to consolidate the research and development elements of the Navy's oceanographic programs into a coherent organization resulted in the establishment of NORDA on 31 March 1976 at the National Space Technology Laboratories (NSTL), Mississippi, as a field activity of the Chief of Naval Research (CNR).

NORDA is one of more than 30 tenant activities located at NSTL, which is operated by the National Aeronautics and Space Administration (NASA). NSTL, located in the southwest corner of Mississippi about 50 miles northeast of New Orleans, Louisiana, encompasses over 200 square miles of land area. This includes a perimeter "buffer" zone which insulates neighboring civilian communities from the noise of rocket engine testing performed by NASA.

NORDA's personnel occupy 59,309 square feet in the main administration building (Bldg. 1100) and general laboratory building (Bldg.1105), which has two NORDA wings. These buildings house NORDA's Numerical (Acoustic) Modeling Division and Remote Sensing and Physical Oceanography Branches, as well as command administrative support personnel, along with NASA contractors, and other tenant organizations.

NORDA's first dedicated building (Bldg.1005), the Ocean Science Center, has 61,315 square feet of space and 5,000 square feet of open storage area. It has been occupied since 1984, by NORDA's Ocean Acoustics, Ocean Technology, and Sea Floor Geosciences Divisions, and by the Command's senior management officials.

Construction has started on a 7,500 square foot Naval Oceanography Program Building, which is scheduled for

FACILITIES (continued)

completion in September 1988. Construction is nearing completion on a 2,625 square foot Airborne Electromagnetic Laboratory for the Mapping, Charting and Geodesy Division, with completion scheduled for November, 1987.

NORDA is also using a 2,400 square foot metal prefab office/warehouse building (Bldg. 2406), 1,200 feet of open storage, housing NORDA's Facilities Branch; a 1,200 square foot Magnetic Observatory building (Bldg. 2437), housing data acquisition systems for research projects using ultra-sensitive magnetometers; and a modular building (Bldg. NMBT-2), housing NORDA's Financial Management Division and Contracts Office.

NORDA has two double-wide trailers (3,696 square feet). Both are occupied by the Civilian Personnel Division, one for a training facility and the other for office administration space.

Staging and storage of seagoing equipment for the Ocean Technology Division is provided by a 10,000 square foot facility (Bldg.1006) adjacent to Bldg.1005. NORDA uses two floors, 58,000 square feet, of the Hebert Center, located in New Orleans, LA, for storage of research and development equipment.

PROGRAM WORK

NORDA has been assigned responsibility for Navy-wide leadership in ocean environmental measurements; development of relevant instrumentation, analysis, and prediction; mapping, charting and geodesy; and environmental ocean acoustics.

NORDA's programs are structured vertically, transitioning from 6.1 through 6.3 levels of responsibility. They are performed by multidisciplinary teams composed of personnel from both within and without NORDA.

These programs develop and employ state-of-the-art instrumentation involving computer and field intensive research and development.

The major thrusts of NORDA's programs for Fiscal Year 1988 are in the areas of:

- Tactical Oceanography
- Bioluminescence
- Low Frequency Active Acoustics
- High Gain Array
- Arctic Research
- Mapping, Charting and Geodesy
- Shallow Water/Port Egress Security

These programs are applied to:

- Gaining Knowledge of Ocean Processes
- System Designs
- Fleet Operations
- ASW System Concept Evaluation
- Operational Oceanographic Surveys
- Search and Recovery Operations
- Systems and Operations Analysis
- New Measurement Methods

These efforts support the following Navy initiatives:

- Antisubmarine Warfare
- Mine Warfare
- Amphibious Operations
- Surface Warfare
- Special Warfare
- Cruise Missiles
- SSBN Security
- Communications
- Forecasting
- Arms Control Monitoring
- Surveys
- Charting
- Platform Design
- Construction and Maintenance

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MAJOR R&D PROGRAMS

OCEAN ACOUSTICS
Arctic ASW Environmental Acoustics Support
Mine Warfare and Countermeasures
Shallow-Water Mode Matching
Very Low- and High-Frequency Acoustics
Seismic Sensors
High-Gain Acoustic Beamforming

NUMERICAL MODELING
Broadband/Narrowband Simulation
Arctic Data Bases
Low Frequency Active Acoustic Modeling
Model Configuration Management
Acoustical Tactical Development and Analysis
Modeling Support to Distributed Systems

OCEAN TECHNOLOGY
Array Design, Fabrication, and Testing
Ocean Cable Design, Analysis, and Deployment
Special Sources
Microprocessor Design
Expert Systems
High Gain Arrays

OCEANOGRAPHY
Wave Research and Forecasting
Fine-Scale Oceanography
Ocean Dynamics from GEOSAT
Optical Oceanography
Biodeterioration of Metals
Chemical Dynamics of Ocean Fronts
Bioluminescence
Bioturbidation
Remote Sensing and On-Ice Arctic Research
Ice Physics

OCEAN SENSING AND PREDICTION
Tactical Oceanographic Modeling
Topographic Effects on Ocean Circulation
Small-Scale Hydrodynamics/Thermodynamics
Thermodynamic Ocean Prediction
Air-Sea Interaction
Four-Dimensional Oceanographic Data Assimilation
Arctic Ice Prediction
Ocean Circulation Forecasting
Ocean Dynamics from GEOSAT
Synthetic Aperture Radar (SAR) Remote Sensing
Satellite Oceanography Tactical Applications

MAPPING, CHARTING, AND GEODESY
Airborne Bathymetric System
- Electromagnetic
- Thematic Mapper Scanner
- Laser Sounder

Multispectral Feature Extraction
Autocartography
Hydrographic Information Handling System
Geoelectric/Geomagnetic Variability
Shuttle Geomagnetics

SEAFLOOR GEOSCIENCES
Bottom/Subbottom Geoacoustics
Engineering Properties of Sediments/Probe Development
VLF/ULF Geoacoustics
Remote Seabottom Classification
Sediment Transport
Seismic Sensor Investigations
High Frequency Scattering

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MAJOR ACCOMPLISHMENTS

Ocean Dynamic Model/Acoustic Model Interface. In 1987 the Harvard Quasi-Geostrophic dynamic ocean model predictions of Gulf Stream and associated cold and warm core ring locations were used to produce three-dimensional range dependent acoustic predictions. The dynamic ocean model predictions of Gulf Stream and eddy locations were used as input to the Tactical Environmental Support System (TESS), currently under development at the Naval Oceanographic Office. The three-dimensional thermal field derived from TESS was used to produce a three-dimensional sound speed data set from which extractions of the sound speed field along great circle paths were performed at 360 one degree radials emanating from single points. Acoustic predictions were produced from these and other environments/acoustic variable extractions made from the Naval Oceanography Test Bed Data Base Management System. These predictions were used to study the influence of the Gulf Stream and associated rings on anti-submarine warfare problems.

Range Dependent Model Evaluation. During FY86 and FY87, NORDA carried out an evaluation of four candidate range-dependent propagation loss models as an aid to OP-006 in selecting a model for onboard acoustic prediction. Four models were submitted for this comparison study. They are: ASTRAL 2.0, an upgrade to the ASTRAL model that will allow prediction of convergence zones and surface ducts; PAP (PE and ASTRAL Program), a hybrid code that will produce a PE prediction if the run times are not excessive, or a combination of PE for RR and RSR path and ASTRAL for bottom-i teracting paths, if the runtime of PE alone is too long; PE (Parabolic Equation), a split-step Fourier transform solution to the parabolic approximation of the wave equation; RDR (Range Dependent RAYMODE) a range-dependent ray trace model that uses the RAYMODE intensity summation routines.

The model results were compared against measured acoustic data. An extensive spread of environmental types was represented by data sets. A final recommendation was based on five criteria laid down by OP-006. Basically, these criteria are as follows: Runtime, Accuracy, Compatibility with the Navy Standard Data Bases, Documentation, and Special Attributions, such as broad band, arrival structure and travel time.

Based on the results of the study, the following recommendation was made to and accepted by OP-006: The optimum solution for the Fleet would be to install PE and ASTRAL 2 with the necessary data bases and a very simple operating system. PE would be available to do the hard problems when time permitted and, if time did not allow, then ASTRAL 2 could do a quick but not as accurate assessment.

NORDA TAC D&E Program. NORDA recently became a

MAJOR ACCOMPLISHMENTS (Continued)

Aircraft observations aboard the NRL P-3 aircraft 150607; shorebased tactical oceanographic predictions by both NORDA and Harvard University ocean models at the Naval Oceanography Command Facility, Keflavik, Iceland; and ship observations aboard the West German ship PLANET. In situ measurements resolved the thermal structure and sound velocity fields of the Norwegian and Iceland Seas on a variety of time and space scales in order to provide initialization and validation data for numerical ocean models and to contribute to an improved understanding of the regional hydrography, circulation and frontal structure in the region. Full resolution HVHRR IR images (7MAY87 to 7JUN87) and GEOSAT altimeter data (NOV86 to NOV87) were collected at NORDA and correlated with aircraft and ship measurements made along altimetry tracks. The ability to forecast ocean thermal structure, currents and acoustic propagation in near real time was demonstrated.

Indian Ocean Model. A one layer reduced gravity, hydrodynamic model of the entire Indian Ocean north of10° S has been used to examine the seasonal cycle of the western Indian Ocean. The model simulates a variety of phenomena in three separate regions. 1) the North Somali Coast-Socorta area; 2) the equatorial (+/-6°) wave guide; 3) the Madagascar region. The distinctive 26-day equatorial oscillations, the splitting of the South Equatorial Current around Madagascar and the seasonal behavior of the respective branches, and the 50-day period oscillations between Madagascar and the equator have been verified by observations and explained dynamically.

Rating The Navy's Ocean Wind and Wave Models. The U.S. Navy and other domestic and foreign agencies routinely run wind and wave models. Are the Navy products the best available? To find out, NORDA compared the U.S. Navy's model analyses with those of other agencies. An ideal method for ranking large-scale wind and wave models became available when the Navy's GEOdesy SATellite (GEOSAT) was launched in 1985. This satellite, like the earlier GEOS-3 and SEASAT satellites, provides real-time, global coverage of surface wind speeds and significant wave heights. NORDA used this data to rank the Navy's wind and wave model performance for 10 March and 10 September 1986. The models were ranked against those of Canada (both military and civilian), the Netherlands, the Federal Republic of Germany, Japan, the U.S. Army, the National Oceanic and Atmospheric Administration (NOAA), and a private U.S. company (Offshore and Coastal Technology). Our results show that the U.S. Navy wave model rates highly compared with all the models listed above.

MAJOR ACCOMPLISHMENTS (Continued)

SARDAX Airborne System. The Naval Air Development Center is flying, on its Synthetic Aperture Radar Test Bed, a state-of-the-art environmental data acquisition system developed by NORDA Known as SARDAX, this airborne system automatically collects thermal and water velocity structure data, via expendable probes (XBT & XCP), on the waters below the test bed aircraft. These data are then processed into information which can be used to identify and quantify those characteristics of the ocean which affect electromagnetic (radar) signal penetrations and returns. SARDAX will assist NADC in gaining a superior understanding of synthetic aperture radar signal propagation and returns from oceanic waters.

World Ocean Model. On 1 Sep 1987 the initial real time operational testing of the first version of the NORDA Ocean Circulation: Evolution, assimilation and Nowcast System/Global (Non-Eddy Resolving) (OCEANS/GNR) commenced at Fleet Numerical Oceanography Center (FNOC), Monterey, CA. The 1 1/2° x 1 1/4° grid, OCEANS/GNR model was delivered to FNOC for implementation on the CYBER 205 in the third quarter of FY87. The model has been forced with the FNOC archived marine winds up to the present time Real time forecasting has commenced and is continuing on a daily basis. This model has proven, when forced with FNOC marine winds, to simulate the wind driven large scale circulation of the global ocean exceptionally well in every area where the results have been compared to available observational data sets. This is the first operational real-time forecasting system for ocean circulation available to the fleet. Results from this model will be used as input to other forecasting models at FNOC.

Polar Ice Prediction System. On 1 Sep 1987 the Commander, Naval Oceanography Command declared the Polar Ice Prediction System (PIPS) to be fully operational. PIPS is an adaptation of the ice model designed by Prof. William D. Hibler of Dartmouth College to run on the FNOC computers. The model is forced by the NOGAPS forecasted winds and updated by Naval Polar Oceanography Center analyses. A regional high resolution ice forecast system for the Barents Sea will be delivered this fiscal year.

Tactical Oceanography. One of NORDA's major long range goals is the development, validation and delivery for operational use of oceanic and acoustic numerical forecast systems and the assimilation of in-situ and remotely sensed data into these forecast systems. Field work was carried out by NORDA personnel and by NORDA-sponsored contractors in May-June 1987. This was Phase I of a continuing series of experiments in the Greenland, Iceland, Norwegian Seas in support of the National Maritime Strategy The field work was divided into three segments:

MAJOR ACCOMPLISHMENTS (Continued)

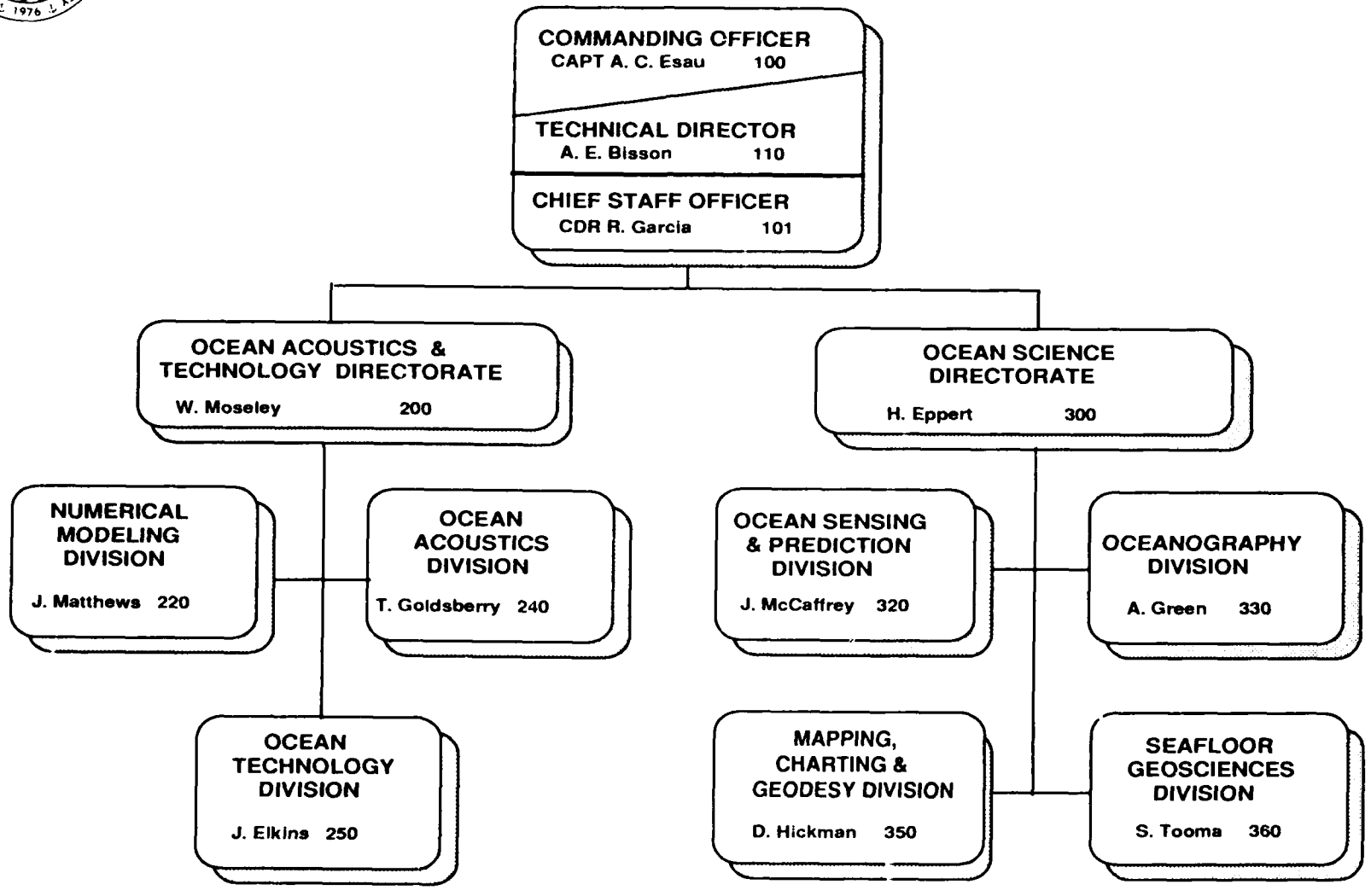
major participant in the TACEVAL phase of the Navy's TAC D&E Program administrated by the Navy's Tactical Support Activity. During the past 18 months, five TACMEMOs drafted by the Surface Warfare Development Group (SWDG) have been evaluated at sea with the fleet. Tactics in four of these TACMEMOs depend heavily on knowledge of the environment for successful employment of ASW assets. NORDA has modified and in some cases developed models to yield the appropriate environmental/acoustic predictions in order to analyze and/or refine the devised tactics under evaluation.

Where applicable, TACAIDS are developed to enhance implementation of baseline tactics; i.e., graphic depth-dependent curves of selected oceans areas to quickly determine target range via bottom bounce, and an environmental matrix to assist in sensor deployment in the vicinity of strong ocean fronts. Various range dependents acoustic models are utilized in TACMEMO evaluations prior to, during, and after relevant TACEVALEXs. In TACMEMOs dealing with tactics around strong ocean fronts/eddies and at convergence zone ranges, FEPE, IFDPE, and CZ ASTRAL models have played a significant role. Once a TACMEMO has been approved, it becomes a TACNOTE and is finalized for publication. Two of the aforementioned five TACMEMOs have progressed to that stage; two are approaching final draft for acceptance, and the last is being revised for SWDG review.

Expert Maintenance Advisor. NORDA, in conjunction with the Navy Artificial Intelligence (AI) Center, has demonstrated to NAVSEA PMS-411 a prototype expert system maintenance advisor for a portion of the AN/SQS-53B surface ship sonar. The prototype is based on FIS (Fault Identification System), an expert system shell developed by AIC. The prototype demonstrates the feasibility and effectiveness of using intelligent computer systems to aid maintenance technicians in quickly diagnosing and repairing complex electronic equipment malfunctions. The prototype contains 3100 expert rules and a sophisticated strategy (Inference Engine) to achieve the correct diagnosis. Future work will entail refinement of the strategy, partitioning of the rule base for faster response, and the addition of an intelligent user interface.

Magnetic Minesweeping Environmental System. NORDA recently completed and delivered to the Naval Oceanographic Office a magnetic minesweeping environmental system called Mini MACAS. Mini MACAS is used to measure oceanic parameters relating to the generation of underwater electromagnetic fields used in sweeping magnetic influence mines. Mini MACAS allows operational forces to accurately determine electric current levels and waveform characteristics that will adequately detonate magnetic mines without endangering mine sweeping platforms. Mini MACAS is already earning its keep, supporting Navy mine warfare operations in the Persian Gulf.

NORDA ORGANIZATION



30 SEPTEMBER 1987

Personnel

AUTHORIZED

FY 87 Civilian Ceiling
378

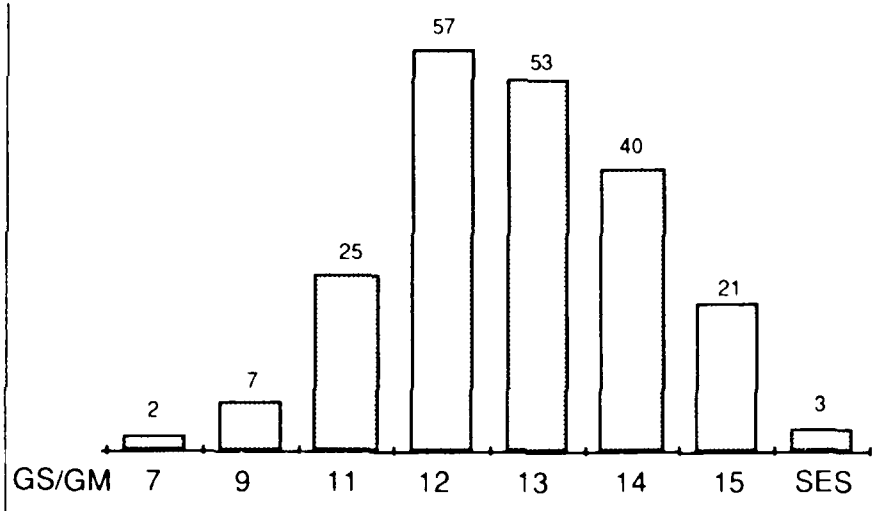
FY 87 Military Allowance
Officers 18 **Enlisted** 0

ON BOARD
30 SEPTEMBER 1987

TOTAL MILITARY	TOTAL CIVILIAN	FTP	FTP GRADED	FTP UNGRADED	TPTI*
10	390	364	361	3	26

*TEMPORARY PART-TIME, INTERMITTENT (EXCLUDES SUMMER EMPLOYEES.)

	FTP On Board
Scientists & Engineers	
Oceanographers	**62**
Physicists	**37**
Phys.Sci.Administrators	**6**
Engineers	**29**
Other Scientific	**75**
Subtotal	**209**
Administrative	**43**
Technicians	**30**
Clerical	**82**
Total	**364**



Scientists & Engineers on board, by grade.

30 SEPTEMBER 1987

FUNDS BY SPONSOR

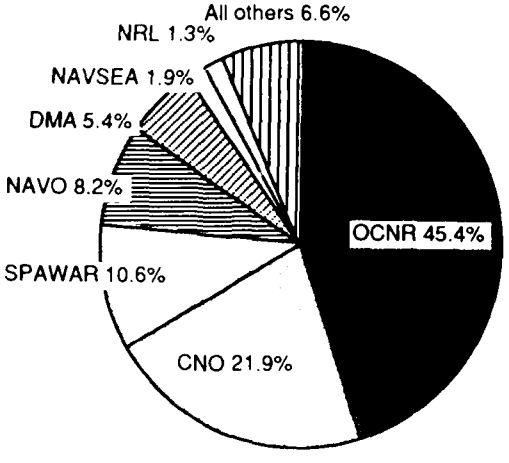
($ in thousands)

	FY 87 (Actual)		FY 88 (Estimated)		FY 89 (Estimated)	
Sponsor	Amount	Percent	Amount	Percent	Amount	Percent
OCNR	22,931	45.4%	23,199	42.6%	22,390	39.0%
CNO	11,029	21.9%	12,598	23.1%	14,168	24.7%
SPAWAR	5,327	10.6%	6,033	11.1%	6,739	11.7%
NAVO	4,121	8.2%	4,667	8.6%	5,213	9.1%
DMA	2,738	5.4%	3,101	5.7%	3,464	6.0%
NAVSEA	948	1.9%	1,074	2.0%	1,200	2.1%
NRL	643	1.3%	728	1.3%	813	1.4%
Other Navy	2,504	5.0%	2,836	5.5%	3,168	5.8%
Other DoD	100	0.2%	113	0.2%	126	0.2%
All others	117	0.2%	133	0.2%	149	0.3%
TOTALS	50,458	100%	54,482	100%	57,430	100%

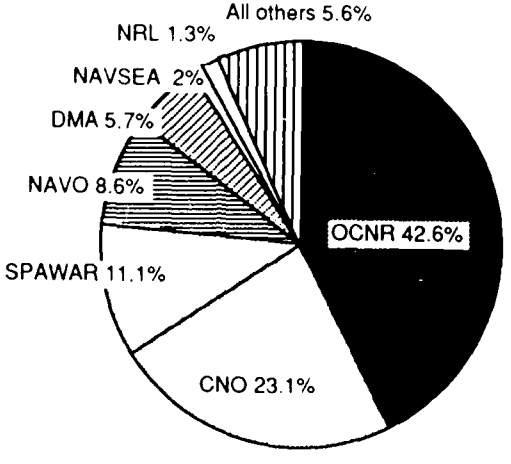
30 SEPTEMBER 1987

FUNDING SOURCES

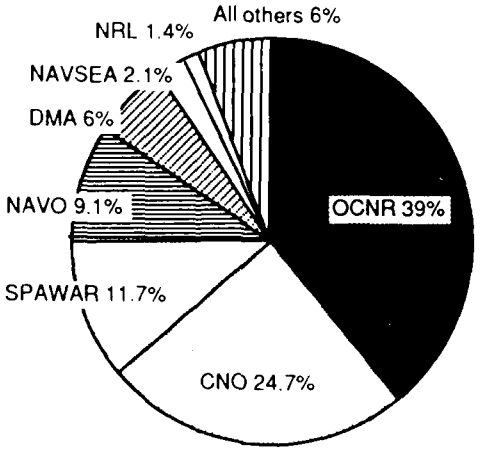
FY 87



FY 88



FY 89



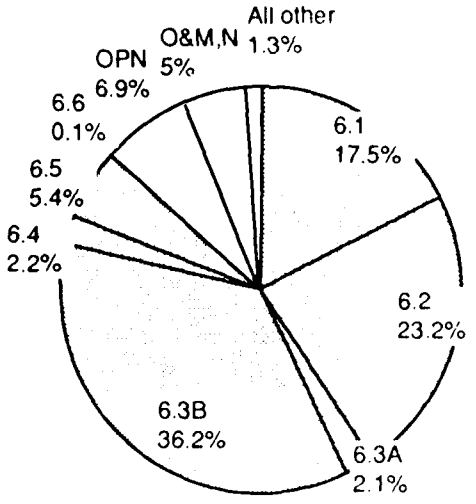
ACRONYMS

CNO	**Chief of Naval Operations**	**NAVSEA**	**Naval Sea Systems Command**
DMA	**Defense Mapping Agency**	**NRL**	**Naval Research Laboratory**
NAVO	**Naval Oceanographic Office**	**OCNR**	**Office of the Chief of Naval Research**
		SPAWAR	**Space and Naval Warfare Systems Command**

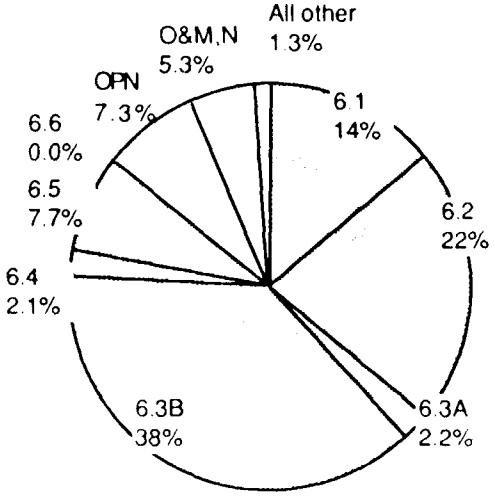
30 SEPTEMBER 1987

FUNDS BY APPROPRIATION

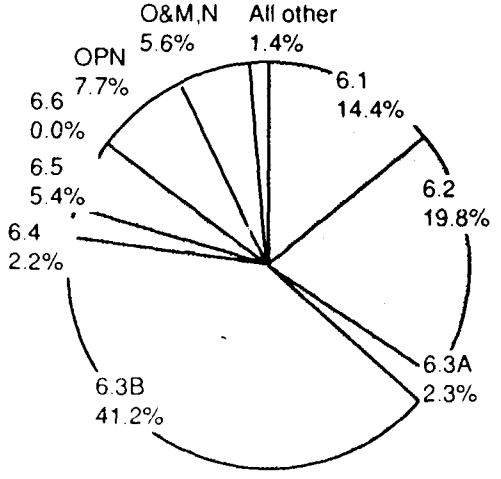
FY 87 (Actual



FY 88 (Estimated)



FY 89 (Estimated)



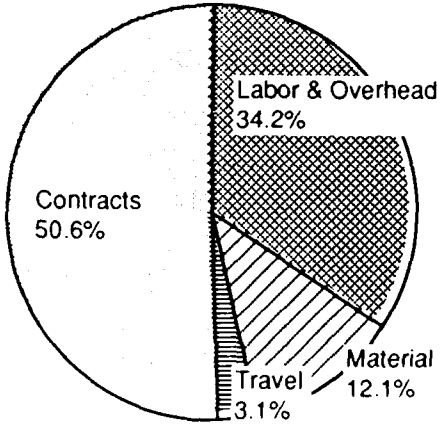
R,D,T & E

OTHER

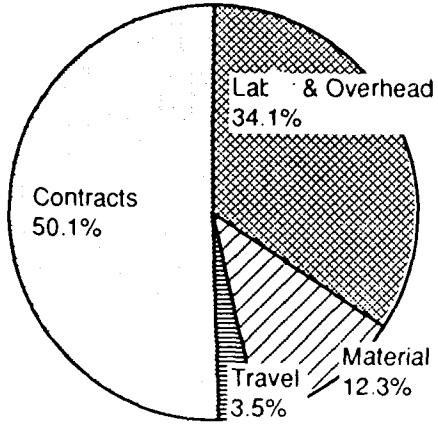
30 SEPTEMBER 1987

DISTRIBUTION OF FUNDS

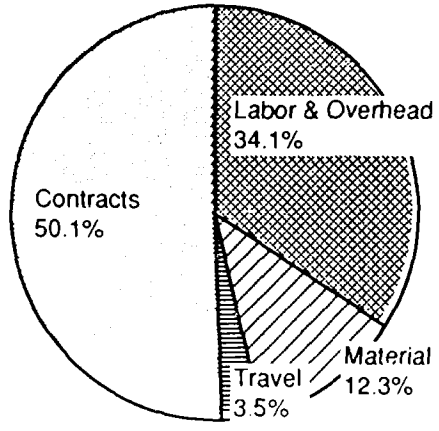
FY 87 (ACTUAL)



FY 88 (ESTIMATED)



FY 89 (ESTIMATED)



30 SEPTEMBER 1987

FUNCTIONS AND RESPONSIBILITIES

The Naval Ocean Research and Development Activity shall plan and conduct an ocean science research and development program and shall establish and maintain a multidisciplinary capability to carry out the following functions:

Initiate, plan, and conduct basic research and exploratory and advanced development in ocean sciences related to the oceans and marine boundaries.

Develop and transition hardened ocean instrumentation and associated oceanographic measurement techniques, models and data bases in response to the operational survey requirements of the Naval Oceanographic Office.

Develop and document analytical models of acoustic, oceanographic and marine boundary layer phenomena pertinent to application at all levels of command for strategic planning, intelligence, hydrography, tactical operations, and warfare systems design.

Maintain cognizance of Fleet ocean environmental support requirements; and plan, manage and conduct research and development needed to provide solutions.

Support research and development requirements for mapping, charting and geodesy, including remote and in-situ sensing and hydrographic survey technology.

Plan and conduct research and development concerned with the collection, analysis, display and use of remotely sensed data from civilian and military satellites.

Provide, as tasked, environmental and acoustic data during the test and evaluation phases of new Navy systems and assist in the evaluation of their performance.

Plan and conduct ocean science and technology in support of the Navy's strategic programs.

Provide a capability to conduct independent assessment of Navy environmental programs and to develop long-range environmental program plans.

Plan and conduct acoustic and other related ocean measurements and analyses to support assessments of the performance of Navy underwater acoustic systems.

30 SEPTEMBER 1987

LEADERSHIP ASSIGNMENTS

NORDA is responsible for Navy-wide leadership in:

1. Performance of principal Navy research, exploratory development, and advanced development for ocean environmental measurement, and development of relevant instrumentation, analysis, and prediction.

2. Mapping, charting and geodesy.

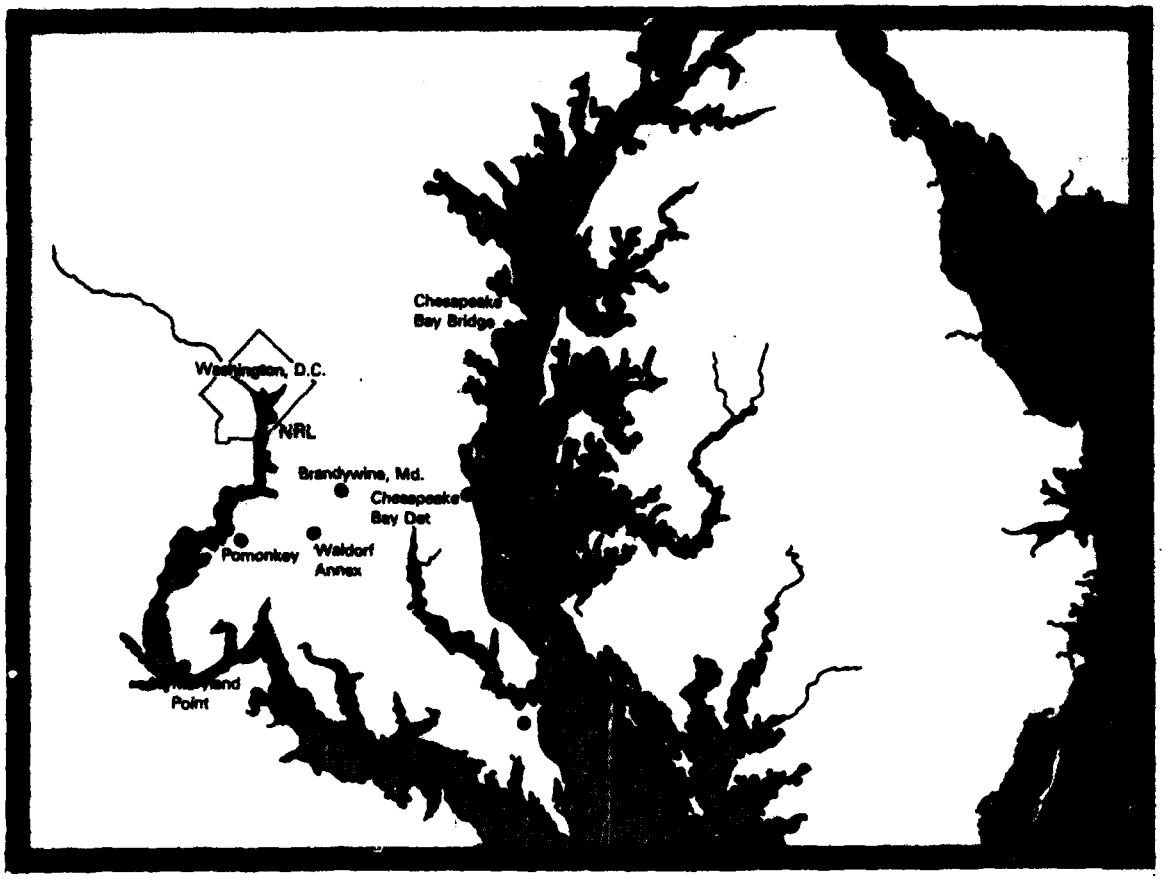
3. Performance of environmental ocean acoustics investigations.

30 SEPTEMBER 1987

NAVAL RESEARCH LABORATORY BRIEF

WASHINGTON D.C. 20375-5000

NAVAL RESEARCH LABORATORY AND PRINCIPAL FIELD STATIONS



The Underwater Sound Reference Detachment is in Orlando, Florida.

30 SEPTEMBER 1987

MISSION

To conduct a broadly based multidisciplinary program of scientific research and advanced technological development directed toward new and improved materials, equipment, techniques, systems, and related operational procedures for the Navy. In fulfillment of this mission, the Naval Research Laboratory:

●Initiates and conducts scientific research of a basic and long-range nature in scientific areas of special interest to the Navy.

●Conducts exploratory and advanced technological development deriving from or appropriate to the scientific program areas.

●Within areas of technological expertise, develops prototype systems applicable to specific projects.

●Performs scientific research and development for other naval commands and, where specially qualified, for other agencies of the Department of Defense and, in defense-related efforts, for other Government agencies.

●Upon request from appropriate naval commands, assumes responsibility as the Navy's principal R&D center in areas of unique professional competence.

●Serves as the principal activity for the Navy and its contractors in providing accurate calibration, test, and evaluation services on acoustic transducers and materials; in providing a service whereby an inventory of calibrated standard acoustic transducers are maintained for issue; and in performing research and development to advance the state-of-the-art of acoustic measurements and standard transducers.

●Performs research and development on sonar transducers and related acoustic materials.

●Furnishes scientific consultative services for the Navy and, where specially qualified, for other agencies of the Department of Defense and, in defense-related efforts, for other Government agencies.

●Provides to the Navy determinations of performance characteristics of developmental and prototype devices through limited engineering test and evaluation services.

INTRODUCTION

The Naval Research Laboratory was officially established on July 2, 1923, as the Naval Experimental and Research Laboratory. In the following six decades, research efforts have expanded from the two original areas of scientific endeavor, of radio and underwater sound to more than 10 broad areas, encompassing such diverse fields as artificial intelligence and fiber optics.

NRL still occupies its original site on the banks of the Potomac River in the southwest corner of Washington, D.C., but the number of buildings there has expanded from the original 5 to more than 130, and the main laboratory site has expanded from 27.5 acres to 129 acres. More than 15 field sites also are used by NRL scientists in pursuit of new knowledge for the Navy and the nation. The original group of about 20 employees has grown to more than 3600.

NRL is the Navy's corporate research laboratory and is under the command of the Chief of Naval Research.

NRL has been designated a major shore command and is led by a naval Captain who serves as Commanding Officer. The principal official who shares responsibilities with the Commanding Officer for directing Laboratory operations is the Director of Research, a senior civilian. The Laboratory's overall management structure is built around four principal directorates and one technology center. Three Research Directorates—each headed by a senior civilian Associate Director of Research—comprise 13 research divisions and detachments established along scientific discipline lines. The Technical Services Directorate, similarly led, consists of seven support divisions and detachments. The Navy Center for Space Technology—also led by a senior civilian Director—consists of three departments and represents the DoD's only in-house space system design, development and fabrication capability.

FACILITIES

PROPERTY DATA

Land Owned/Leased:	1181 acres
Buildings:	
RDT & E	2,643,470 square feet
Administrative	194,307 square feet
Other	272,993 square feet
Acquisition Costs:	
Real Property (Classes I & II)	$124.2 million
Equipment (Classes III & IV)	$242.4 million

SIGNIFICANT RESEARCH FACILITIES AND CAPABILITIES

(Listed alphabetically by organizational unit)

Acoustics Division

- Large tank instrumented for investigating acoustic echo characteristics of targets
- Tank 9.1-m (30-ft) in diameter by 6.7-m (22-ft) deep, automated with computer control and analysis for detailed studies of acoustic fields, transducers, and other underwater devices.
- Multichannel Programmable Digital Data Processing System: a system of DEC computers, high-speed array processors, and peripherals for up to 256 channels; designed for acoustic surveillance array processing

Chemistry Division

- Biomolecular Engineering Facility
- Scanning Electron Microscope
- Scanning Auger Microprobe
- Scanning Tunneling Microscope
- 300 MHz Nuclear Magnetic Resonance Spectrometer
- Paint and Coating Facility
- Mechanical and Chemical Characterization of Polymers Facility
- Alternate and Petroleum-Derived Fuels Facility
- Combustion Research Facilities
- CAMECA Ion Beam Microprobe
- High-Temperature Chemistry Facility
- Ex-SHADWELL, 475 ft. Fire Safety Test Platform

Condensed Matter and Radiation Sciences Division

- 60-MeV Linear Electron Accelerator (Linac)
- 3-MV Positive Tandem Ion Van de Graaff Accelerator
- Ion Implantation Facility
- 2-MV Electron Van de Graaff Accelerator
- Cobalt-60 source
- Hypervelocity gun ranges
- Synchrotron Radiation Beam Lines (UV and x-ray)
- 2-GW Nd Pulsed Laser System

Electronics Technology Division

- Microelectronics Processing Facility
- Electron Beam Lithography System
- Advanced Plasma Etching Systems
- Electron microscopes and electrooptical analytical devices

FACILITIES (CONTINUED)

Crystal-growing facilities including Molecular Beam Epitaxy, Organo-Metallic CVD, Liquid Encapsulated Czochralski, and Electro-Dynamic Gradient Freeze
High Magnetic Field Facility
Vacuum Electronics Facility
A variety of electronic testing and analysis facilities

Information Technology Division

Radio Antenna Range
Free-Space Antenna Range
Counter Communication Laboratory
Analysis Laboratory
Network Simulation Prototype Test Bed
Voice/Signal Processing Facility
Mobile Jammer Facility
Battle Management Test Bed
Butterfly Machine Parallel Processor
Computer Facilities include: VAX 11/785, 11/780s, 11/750s, Gould 9005, LMI Nu, and Symbolics.

Laboratory for Computational Physics and Fluid Dynamics

State-of-the-art capabilities in fluid dynamics, computational physics and related fields
Two VAX 11/780s plus peripherals, terminals, Network connections to MILNET, LANL, Cray X-MP and NRL Nicenet, APTEC 10C and multiple NUMERIX Array Processors, Tektronix 4115 B, Iris 4D, Metheus and Evans & Sutherland Graphics Stations
DICOMED D-38 Design Station and NRL DICOMED microfilm recorder
Wave Channel: a 30-m channel with fan and mechanical wave-maker instrumented for the study of wave generation and wave effects
Water tunnel: a large water channel with a 15-m long test section for turbulence and flow-induced noise and vibration research
Tow channel: a 20-m dual carriage tow channel with variable stratification for studies of geophysical flows and wakes

Laboratory for Structure of Matter

Two x-ray diffractometers
Chromatography

Material Science and Technology Division

UHF Multilayer Preparation Facility
Ultrasonic gas atomizer
Hot isostatic press
Mossbauer facilities
High energy dispersive x-ray analytical system
Electron microscope SEM and STEM systems
Quantitative metallography
Computer-controlled multiaxial loading and stress corrosion cracking measurement systems
Computer interactive nonlinear multimode fracture measurement system
Crystallite orientation distribution function (CODF)
Impression creep and mechanical property evaluation
Automated physical constant measurement system
Helium-3 Dilution Refrigerator

FACILITIES (CONTINUED)

Closed-loop low and high-cycle fatigue systems
High energy CW and pulsed lasers
Electron beam welder
Computer-aided Experimental Stress Analysis
Marine Corrosion Facility

Naval Center for Space Technology

CAD/CAM Facility
R.F. Anechoic Chambers
Thermal-vacuum chambers
Reverberation Chamber
Shock and Vibration Test Facility
Clean-room facilities
Satellite tracking, command, and control facilities
30.5-m (100 ft) wave tank for studying the dynamics of wind waves and their interactions with long waves; uses microwave Doppler spectrometry and optical and photometric techniques
Spacecraft Fabrication and Assembly Facility

Optical Sciences Division

Electron-beam, electron-beam sustained, x-ray, and UV preionized laser devices with spectroscopic and other diagnostic equipment
Short-pulse excitation apparatus for kinetic mechanisms investigations
Optical Warfare Laboratory
Mobile, high precision optical tracker
Facilities for synthesis and characterization of optical glass compositions and for the fabrication of optical fibers
Hybrid optical/digital image processing facility
Facilities for fabricating and testing integrated optical devices
Optical probes laboratory to study viscoelastic, structural, and transport properties of molecular systems
Computer IR/EO Technology/Systems Simulation Center
100-J UV Laser Research Facility
High Energy Pulsed Chemical Laser Laboratory
Field-qualified EO/IR measurements devices
Focal Plane Array Evaluation Facility
Optical Materials Characterization Facility
Mid-IR Laser Research Facility

Plasma Physics Division

PAWN, 1 MJ Compact Inductive Storage Facility
Gamble I and II High-Voltage Pulsed Power Generators
PHAROS III 1.5-KJ Three-Beam Neodymium-Glass Laser (1.05 and 0.53 μm) and Target Facility
1000-J NRL CO_2 Laser
7-MJ Homopolar Generator
High Power Free-Electron Laser and Gyrotron Facilities
Modified Betatron Accelerator
20-m Long Charged Particle Beam (CPB) Propagation Range; Super IBEX (5-MV, 100-kA, 40 μs) Blumlein CPB Generator; Maxibeam (3-MV, 60-kA, 300 μs) Pulseline CPB Generator; 400-J Neodymium Glass Laser (1.05, 0.53, and 0.26 μm); Two VAX 11/780 and One VAX 11/750 Computers, Plus Terminals and Peripherals

Radar Division

Electronic Computer-Aided Design Facility
Airborne Adaptive Array Laboratory

FACILITIES (CONTINUED)

Radar Cross Section Prediction Facility
Radar research and development test beds (at CBD)
Versatile C-, X-, and K_a-band monopulse precision tracking radar systems (at CBD)
IFF ground station
Radar Display Test Bed
Airborne APS-116 radar with ISAR processing
Phased Array Radar Test Bed
Non-Cooperative Target Recognition Facility
Antenna Measurement Laboratory
Digital Signal Processing Facility
Digital Image Processing Laboratory
Land, Air and Laboratory Radar Cross Section Measurement Systems

Research Computation Division

Cray XMP computer (front ended by four DEC VAX 11/785 computers); an extremely large, high speed, powerful computational system particularly well suited for scientific and engineering usage.

Space Science Division

Waldorf Annex (lower site). This facility is instrumented for continuous recordings of atmospheric-electricity, micrometeorologic and lightning-flash data, and is utilized for numerous investigations into environmental phenomena.
22-m Optical Interferometer at Mt. Wilson, CA
Ionospheric sensing and propagation analysis
26-m (85-ft) radio telescope at Maryland Pt., Md.
Other antennas for radio astronomy
E.O. Hulburt Center for Space Research
Development and test facilities for spaceborne instruments to perform astrophysical, solar, high atmospheric, and space environment sensing
Clean-room facilities
Extensive computer-assisted data manipulation and interpretive capability for space-data imaging and modeling

Tactical Electronic Warfare Division

Mobile Infrared Signature Measurement and Simulation Facility
Mobile ESM Laboratory
IR/EO Calibration Facility
Central Target Simulation Facility for developing, testing, and evaluating EW systems and techniques, using real-time, hardware-in-the-loop models
RF Simulation Laboratory and signal simulators
Radar Cross Section Measurement Facility (at CBD)
Search Radar ECM simulator
Advanced Tactical EW Environment Simulator
Ship and Air Systems Anechoic Test Chambers
Antenna Isolation Anechoic Test Chamber
Antenna Compact Range
Mobile tracking radar for trajectory analysis

Underwater Sound Reference Detachment (Orlando, FL)

2.8-hectare (7-acre) lake with a large pier and instrumentation for underwater acoustic studies

Anechoic tank for simulating ocean depths up to 700 m (2297 ft)
Smaller pressure vessels for simulating depths to 7000 m (22,966 ft)
Field station at Bugg Spring with floating platform and instrumentation for acoustic measurements

NRL'S MAJOR FIELD SITES AND STATIONS

Note that the Chesapeake Bay Detachment and the Underwater Sound Reference Detachment are actually field stations with division status. The following four major field sites, all in Maryland, are shown on the preceding map.

MARYLAND POINT has two radio telescopes with antenna dishes 25.6-m (84 ft) and 26 m (85 ft) in diameter for radio astronomy research.

POMONKEY has a free space antenna range for developing and testing a variety of antennas.

TILGHMAN ISLAND This multiple research site has facilities for work in communications, optics, atmospherics, and other fields. It serves as the eastern terminal for an over-the-water range with CBD as the western terminal.

WALDORF has an 18.3-m (60-ft) X-band antenna and an S-band antenna of the same size for space and communications research.

MOBILE RESEARCH PLATFORMS

Air Platforms:

Three four-engine turboprop P-3A Orion aircraft

One four-engine turboprop P-3B Orion aircraft

The Orion aircraft are especially configured for scientific support. The ASW suites have been removed and the interiors have been converted for research project installations.

Sea Platform:

One ship, the Ex-SHADWELL, for R&D on Fire and personnel protection.

PROGRAM WORK

The following areas represent broad fields of NRL research. Underneath each are more specific topics that are being investigated for the benefit of the Navy and other sponsoring organizations. Some details of this work are given in NRL's Review, published annually. More specific details are published in reports on individual projects provided to sponsors and presented when feasible as papers for professional societies or their journals.

Computer Science and Artificial Intelligence

Standard Computer Hardware, Development Environments, Operating Systems, and Runtime Support Software
Methods of Specifying, Developing, Documenting, and Maintaining Software
Techniques for Naval Needs
Expert Systems for Resource Allocation, Signal Identification, Operational Planning, and Target Classification

Device Technology

Integrated Optics
Radiation-Hardened Electronics
Microelectronics
MM Wave Technology
Hydrogen Masers for GPS

Directed Energy Technology

High-Energy Lasers
Chemical Lasers
Laser Propagation
High-Power Microwave Sources
Charged-Particle Devices
Pulse Power

Electronic Warfare

Decoys (RF and IR)
Repeaters/Jammers, EO/IR Active Countermeasures
EW/C^3CM System Concepts

Enhanced Maintainability, Reliability, and Survivability Technology

Coatings
Lubricants and Greases
Water Additives and Cleaners
Fire Safety
Laser Hardening
Satellite Survivability

Environmental Effects on Naval Systems

Meteorological Effects on Electro-optical System Performance

PROGRAM WORK
(CONTINUED)

Air Quality in Confined Spaces
Electromagnetic Background in Space
Solar Activity
Ionospheric Behavior

Information Management

Antijam Communication Links
Network Architectures
Combat Management Information Systems

Materials

Material Processing
Advanced Alloy Systems
Rapid Solidification Technology
High-Temperature Materials
Laser Fabrication and Processing
Ceramics and Composite Materials
Biomolecular Engineering
Superconductivity

Space Systems and Technology

Advanced Space Systems
Space Sensing Applications
Satellite Communications
Spacecraft Design, Engineering, and Integration
Satellite Ground Station Design
Navigation Systems

Surveillance and Sensor Technology

Imaging Radars
Target Classification/Identification
Towed Acoustic Arrays
Underwater Acoustic Propagation
Electromagnetic Sensors-Gamma Ray to RF Wavelengths
SQUID for Magnetic Field Detection
Low Observables Technology

Undersea Technology

Autonomous Vehicles
Bathymetric Technology
Anechoic Coatings

MAJOR ACCOMPLISHMENTS

RADAR CROSS-SECTION PREDICTION

A radar cross-section (RCS) computer prediction program, called Radar Target Signature (RTS), has been developed to predict the RCS of targets. For many years the only way to obtain the RCS of a target was by actual measurement. This was an expensive procedure and it required the existence of the target or a scale model. RTS can now be employed in the design phase of weapons systems and platforms to examine various alternative designs for the lowest RCS, and it can also be used to evaluate methods of reducing the RCS of existing ships, aircraft, and missiles.

FIBER OPTIC RADAR

NRL has demonstrated the feasibility of signal distribution and conditioning using optical techniques in phased arrays instead of the more classical microwave corporate power division and discrete phase shifting. This accomplishment allows for simpler, lighter, smaller and more robust arrays which require less power for beam control and less communications with the array. When available for deployment, this technology will enable multi-function phased array, frequency agile radars to be incorporated on even the smallest Naval platforms.

ION-TRANSPORT CHANNEL ON A MOLECULAR LEVEL

A potentially important phenomenon has been discovered using X-ray diffraction analysis whereby a molecular level picture has been developed of an ion-transport channel formed by an antibiotic peptide. This new knowledge is significant because ion transport through cell membranes is a physiological process that is essential for life processes. This new atomic structural information has significance for protein engineering, drug design, antibiotic activity, and concepts of ion-transport mechanisms.

SPECIAL SENSOR MICROWAVE/IMAGER (SSM/I) SATELLITE INSTRUMENT

As part of the SSM/I calibration and validation effort, NRL RP-3A aircraft wit a complement of accurately calibrated radiometers underflew the SSM/I over both ocean and terrain surfaces. The results of the underflights demonstrated that the SSM/I is a well calibrated microwave imager. Environmental information available from the SSM/I is processed by the Fleet Numerical Oceanography Center and the Air Force Weather Center to obtain near real-time global precipitation maps, sea ice morphology, marine surface wind speed, columnar integrated water vapor, and soil moisture percentage.

EFFECT OF MOLD PRESSURE ON AN ELASTOMER'S ELECTRICAL RESISTIVITY

The U.S. Navy has been intermittently troubled by rubber compounds that have exhibited high resistivity in laboratory-molded samples and then inexplicably have shown much lower resistivity when molded into underwater electroacoustic devices. This problem is typically discovered after the device has already been placed into Fleet operation, wh n an in-service failure can cost tens of millions of dollars. NRL research has

MAJOR ACCOMPLISHMENTS
(CONTINUED)

demonstrated that the electrical resistivity of the rubber is a strong function of molding pressure and that the pressure at which the decrease in resistivity occurs depends inversely on the concentration of carbon black. This new knowledge will be utilized in future Navy procurements of sonar transducers.

NUMERICAL MODELING OF MESOSCALE WEATHER

A dynamic weather prediction system has been developed for the analysis and prediction of maritime storms. Due to their rapid intensification, fast speed and destructive force, these storms disrupt Naval system performance, hinder Naval operations, and sometimes damage Naval assets. An early version of the weather prediction system is now a component of the Naval Operational Regional Atmospheric Prediction System. A more recent version, now under operational testing at the Naval Environmental Prediction Research Facility, will become the operational tropical cyclone prediction model.

NEW TOOL FOR ELECTRONIC MATERIAL CHARACTERIZATION

An optical characterization tool based on modulation spectroscopy has been developed to characterize electronic materials. The technique, called Photoreflectance (PR), is contactless, non-destructive, and can be of great utility in quantifying and qualifying crystal samples. Composition and carrier concentration on a freshly grown sample can now be determined in less than ten minutes. A private firm is in the process of building a PR prototype based on the NRL design with the intent of making it commercially available as a laboratory characterization tool.

DISCOVERY OF FAR ULTRAVIOLET GLOW FROM LOW ALTITUDE SPACECRAFT

Nadir-viewing far ultraviolet observations obtained by satellite show that the daytime N_2 Lyman-Birge-Hopfield emission exhibits a change in vibrational distribution and becomes substantially brighter than predicted from photoelectron theory when the satellite is near perigee. At night, the intensity depends on altitude. Analysis has shown that the emission is related to the passage of the spacecraft through, and its reaction with, the atmosphere.

MODEL FOR IONOSPHERE-MAGNETOSPHERE COUPLING

A multimoment, multifluid plasma simulation modelling method has been developed, evaluated, and shown to be suitable for use in the study of large scale near-earth plasma dynamics. This generalized fluid model is more realistic than the idealized magnetohydrodynamic models currently in use in the study of large-scale magnetospheric-ionospheric interactions, and is expected to yield significant improvement in our ability to understand and eventually predict the state of the

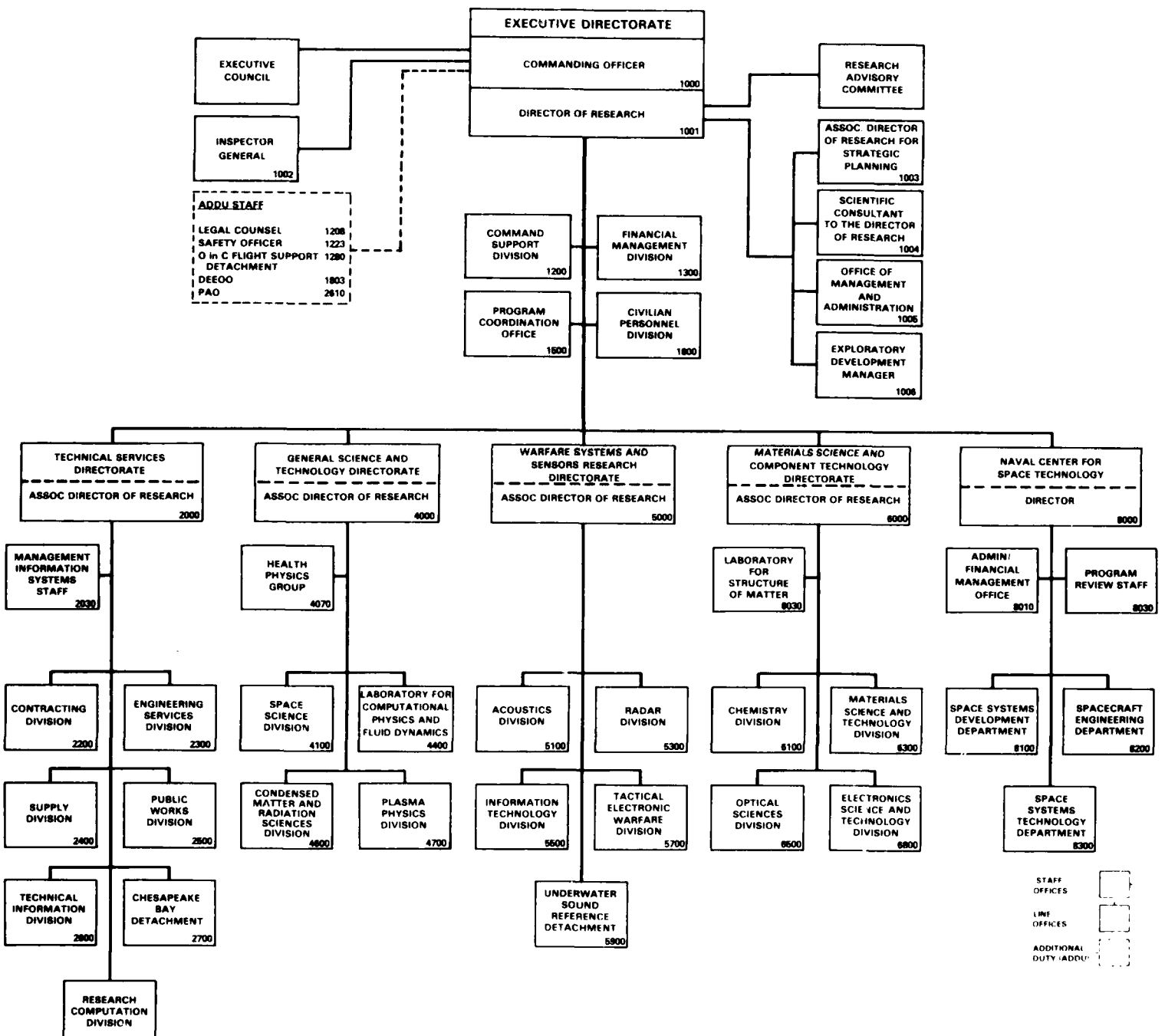
MAJOR ACCOMPLISHMENTS
(CONTINUED)

space plasma environment in which important Naval C^3I, navigation, and radar systems operate.

MARK XV IFF DEVELOPMENT

To make effective use of beyond visual range weapon systems, the U.S. armed forces require a more reliable and less vulnerable Identification, Friend or Foe (IFF) system; the system must also be compatible with NATO so as to allow the interoperability of Allied forces. NRL contributions to the Tri-Service Mark XV IFF Program have shown the importance of maintaining the compatibility of the Mark XV design form, fit, and function with the deployed Mark XII system. These contributions can lead to a reduction of the risks associated with the system's development and lead to a cost savings of several hundred million dollars.

NAVAL RESEARCH LABORATORY



PERSONNEL

CIVILIAN

FTP

Graded	2960
Ungraded	440
Total	3400

TPTI	285
Total Civilian	3685

GRADED FTP BREAKDOWN

Scientists, Engineers, and SES	1556
Administrative – Professional	39
Administrative—Management	345
Technicians	538
Other-Clerical	420
Other-General	62
Total	2960

Civilian Work Year Allocation	3576

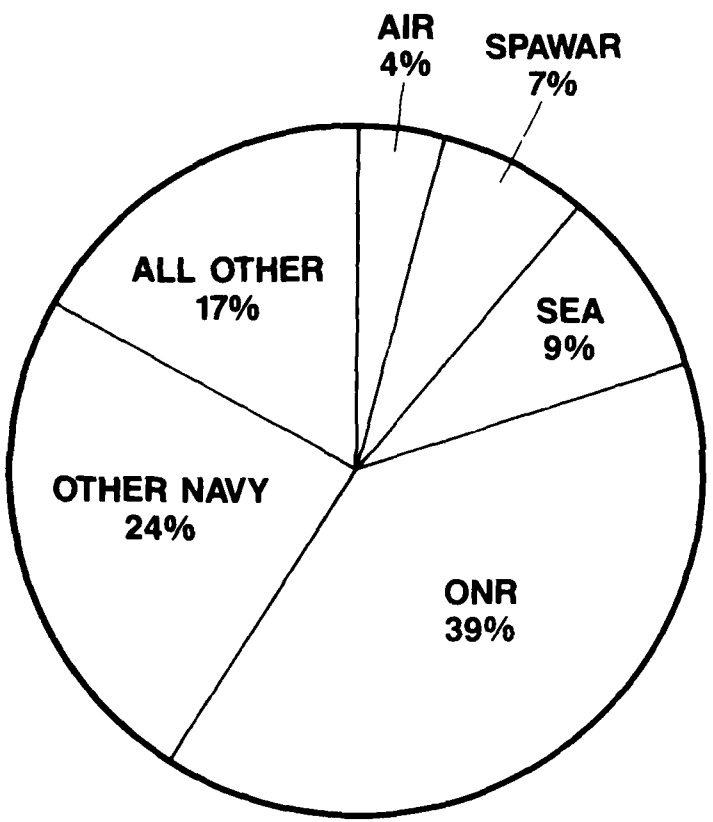
MILITARY

Officers	40
Enlisted	104
Total Military	144
Military Allowance	150

On Board	Tot. Military	Tot. Civil.	FTP	TPTI	FTP Ungraded	FTP Graded
3829	144	3685	3400	285	440	2960

30 SEPTEMBER 1987

FY 87 — ACTUAL REIMBURSABLE FUNDS



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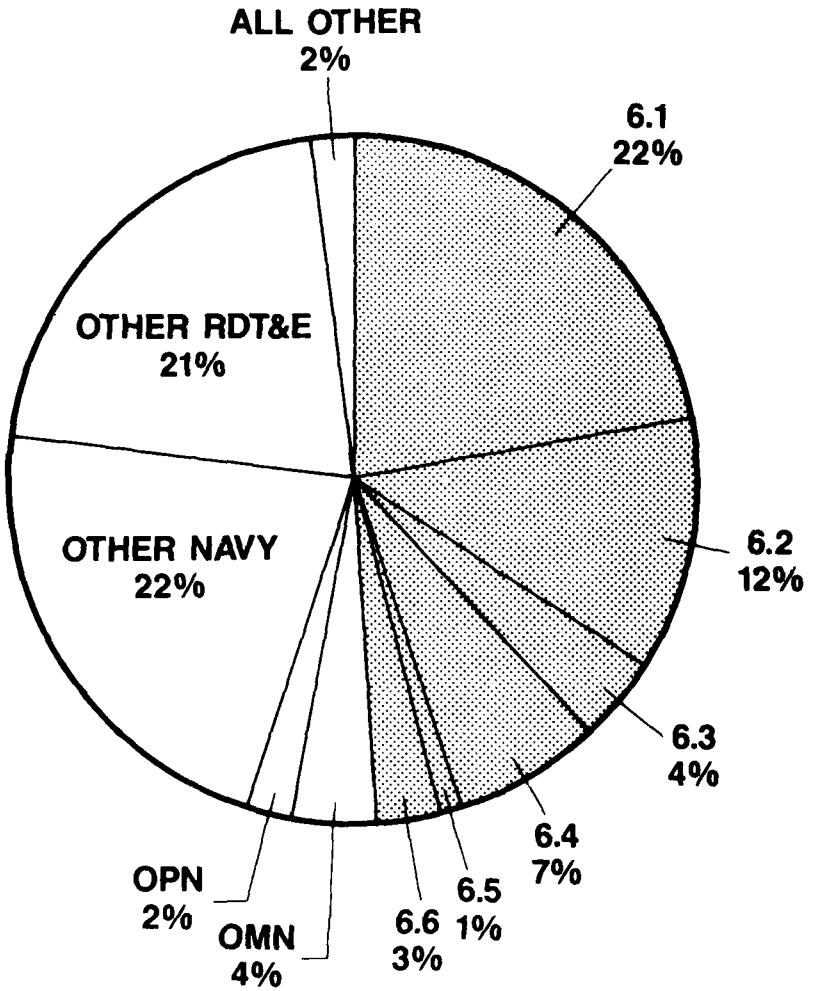
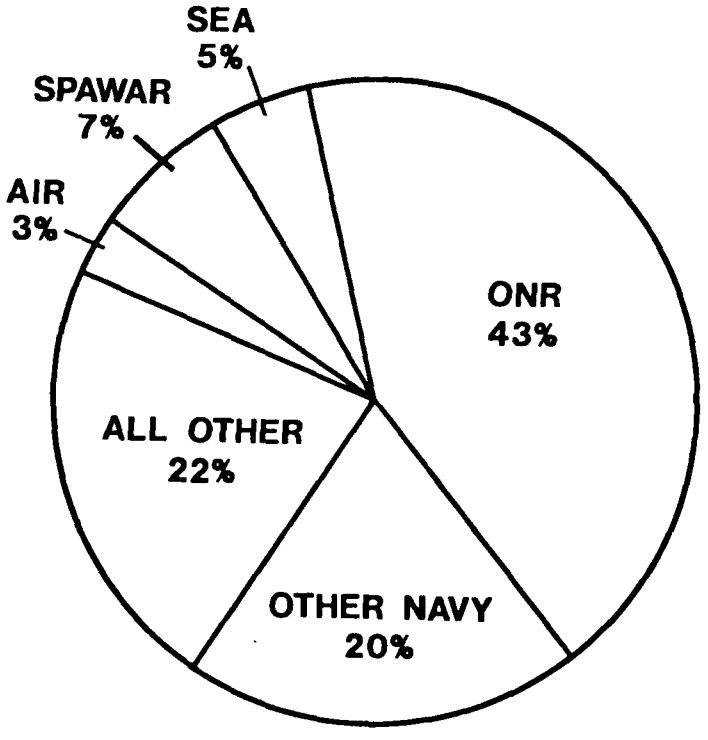


FUNDING BY APPROPRIATION

30 SEPTEMBER 1987

FY 88 - ESTIMATED REIMBURSABLE FUNDS



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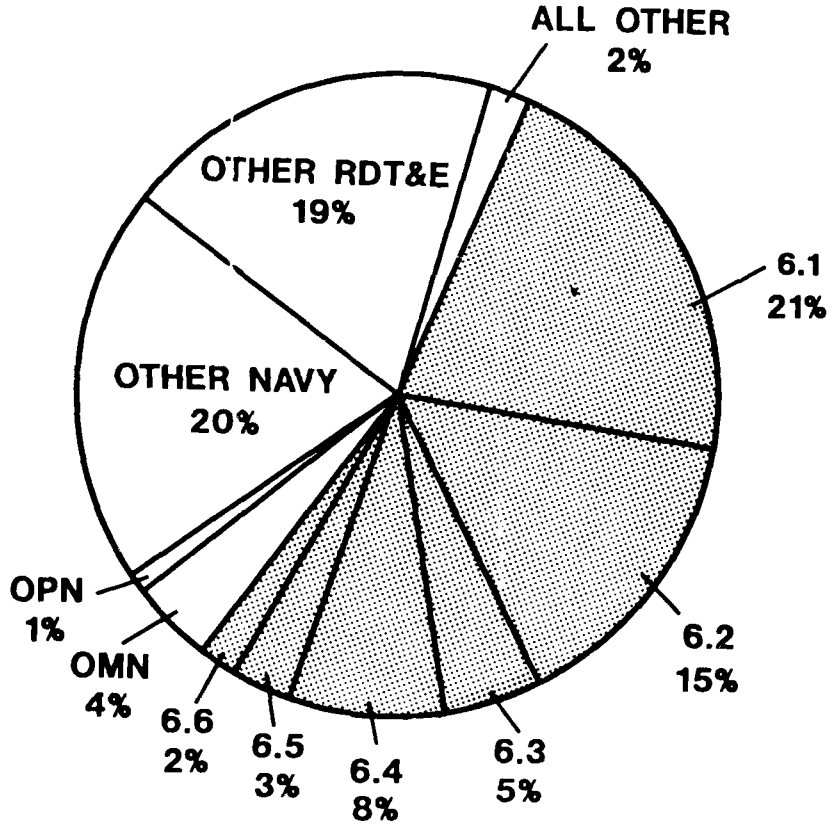
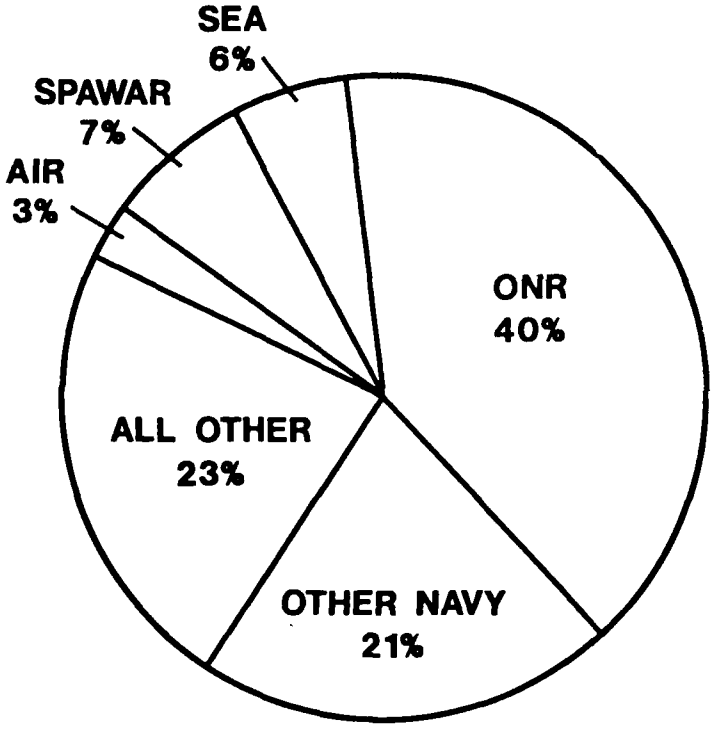


FUNDING BY APPROPRIATION

30 SEPTEMBER 1987

FY 89 - ESTIMATED REIMBURSABLE FUNDS



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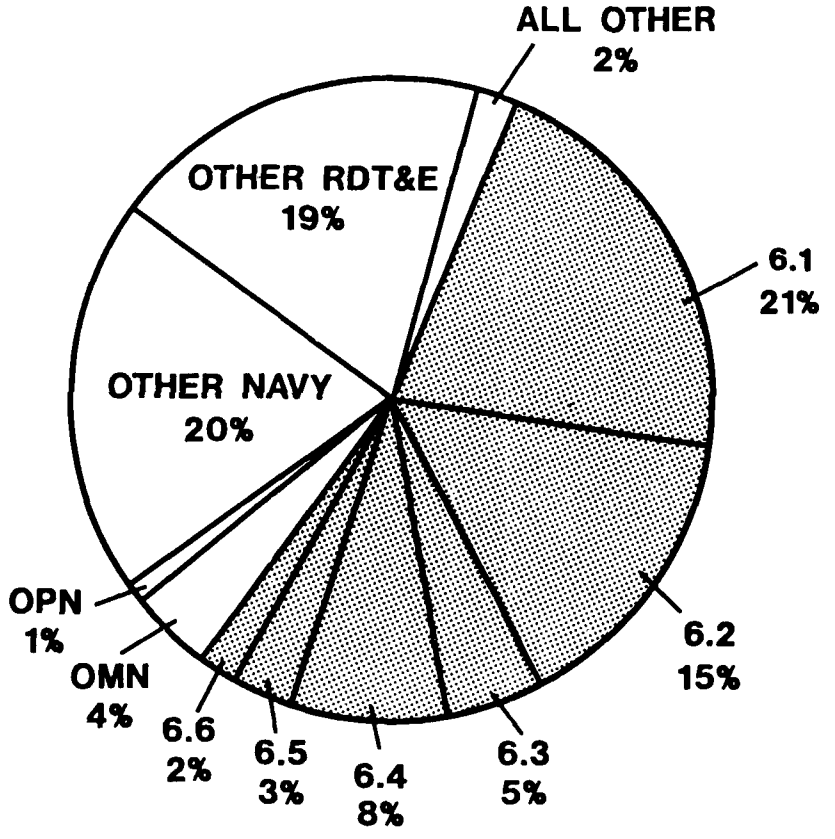


FUNDING BY APPROPRIATION

30 SEPTEMBER 1987

FUNDS BY CATEGORY AND TYPE

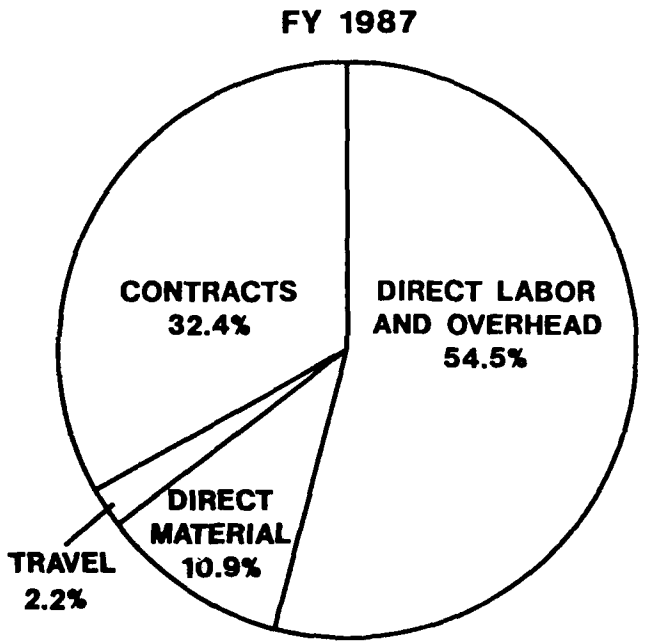
NOR
$ IN MILLIONS

CATEGORIES $ TYPE REIMBURSABLE FUNDS	FY 1987 $M ACT.	FY 1987 % OF RDT&E	FY 1987 % OF TOTAL	FY 1988 $M EST.	FY 1988 % OF RDT&E	FY 1988 % OF TOTAL	FY 1989 $M EST.	FY 1989 % OF RDT&E	FY 1989 % OF TOTAL
RDT&E, N									
6.1 RESEARCH	69.9	31.8	22.2	74.3	28.8	20.9	76.5	28.7	20.9
6.2 EXPLORATORY DEVELOPMENT	36.2	16.5	11.5	52.6	20.4	14.7	54.2	20.4	14.7
6.3a ADVANCED TECHNOLOGY DEVEL.	1.3	.6	.4	5.7	2.2	1.6	5.9	2.2	1.6
SUBTOTAL	107.4	48.9	34.1	132.6	51.4	37.2	136.6	51.3	37.2
6.3b ADVANCED DEVELOPMENT	12.8	5.8	4.1	11.1	4.3	3.1	11.4	4.3	3.1
6.4 ENGINEERING DEVELOPMENT	22.2	10.1	7.0	28.8	11.1	8.1	29.7	11.2	8.1
6.5 MANAGEMENT AND SUPPORT	2.9	1.3	.9	9.4	3.6	2.6	9.7	3.6	2.6
6.6 OPERATIONAL SYSTEMS DEVEL.	10.0	4.5	3.2	8.0	3.1	2.2	8.2	3.1	2.2
RDT&E, N SUBTOTAL	155.3	70.6	49.3	189.9	73.5	53.2	195.6	73.5	53.2
OTHER RDT&E	64.7	29.4	20.5	68.6	26.5	19.2	70.7	26.5	19.2
TOTAL RDT&E	220.0	100.0	69.8	258.5	100.0	72.4	266.3	100.0	72.4
OTHER APPROPRIATIONS									
(OPN) OTHER PROCUREMENT, NAVY	5.1		1.6	5.3		1.5	5.5		1.5
(APN) AIRCRAFT PROCUREMENT, NAVY	1.2		.4	1.2		.3	1.2		.3
(WPN) WEAPONS PROCUREMENT, NAVY	2.3		.7	2.4		.7	2.5		.7
(O&MN) OPER. & MAINT., NAVY	13.5		4.3	13.9		3.9	14.3		3.9
OTHER NAVY	68.7		21.7	70.8		19.9	72.9		19.9
OTHER	4.6		1.5	4.7		1.3	4.8		1.3
TOTAL OTHER APPROPRIATION	95.4		30.2	98.3		27.6	101.2		27.6
TOTAL REIMBURSABLE	315.4		100.0	356.8		100.0	367.5		100.0
DIRECT CITE FUNDS	236.6			243.7			251.0		
TOTAL FUNDS	552.0			600.5			618.5		

30 SEPTEMBER 1987

NEW ORDERS RECEIVED (NOR)
$ IN MILLIONS

DISTRIBUTION OF REIMBURSABLE FUNDS



	FY 1988	FY 1989
DIRECT LABOR & OVERHEAD	222.0	227.1
MATERIALS*	21.3	21.3
TRAVEL	8.5	8.8
CONTRACTS	105.0	110.3
TOTAL REIMBURSABLE FUNDING	356.8	367.5
DIRECT CITE FUNDING	243.7	251.0
TOTAL NRL FUNDING	$600.5	$618.5

* ALSO INCLUDES OTHER COSTS, SUCH AS ADP CHARGES, TUITION, ETC.

FY 87 FUNDING

REIMBURSABLE FUNDING	315.4
DIRECT CITE FUNDING	236.6
TOTAL	$552.0

NOTE: FY 87 DIRECT CITE FUNDING OF $236.6M NOT REFLECTED IN ABOVE CHART.

30 SEPTEMBER 1987

NAVAL RESEARCH LABORATORY (NRL)

MISSION: To conduct a broadly based multidisciplinary program of scientific research and advanced technological development directed toward new and improved materials, equipment, techniques, systems, and related operational procedures for the Navy.

RESPONSIBLE FOR NAVY-WIDE LEADERSHIP* IN:

a. The performance of primary in-house research for the physical, engineering, and environmental sciences.

b. The conduct of a broadly based exploratory and advanced development program in response to identified and anticipated Navy needs.

c. The development of space systems for the Navy.

*Source: NAVMATINST 5450.27C of 1 August 1983

30 SEPTEMBER 1987